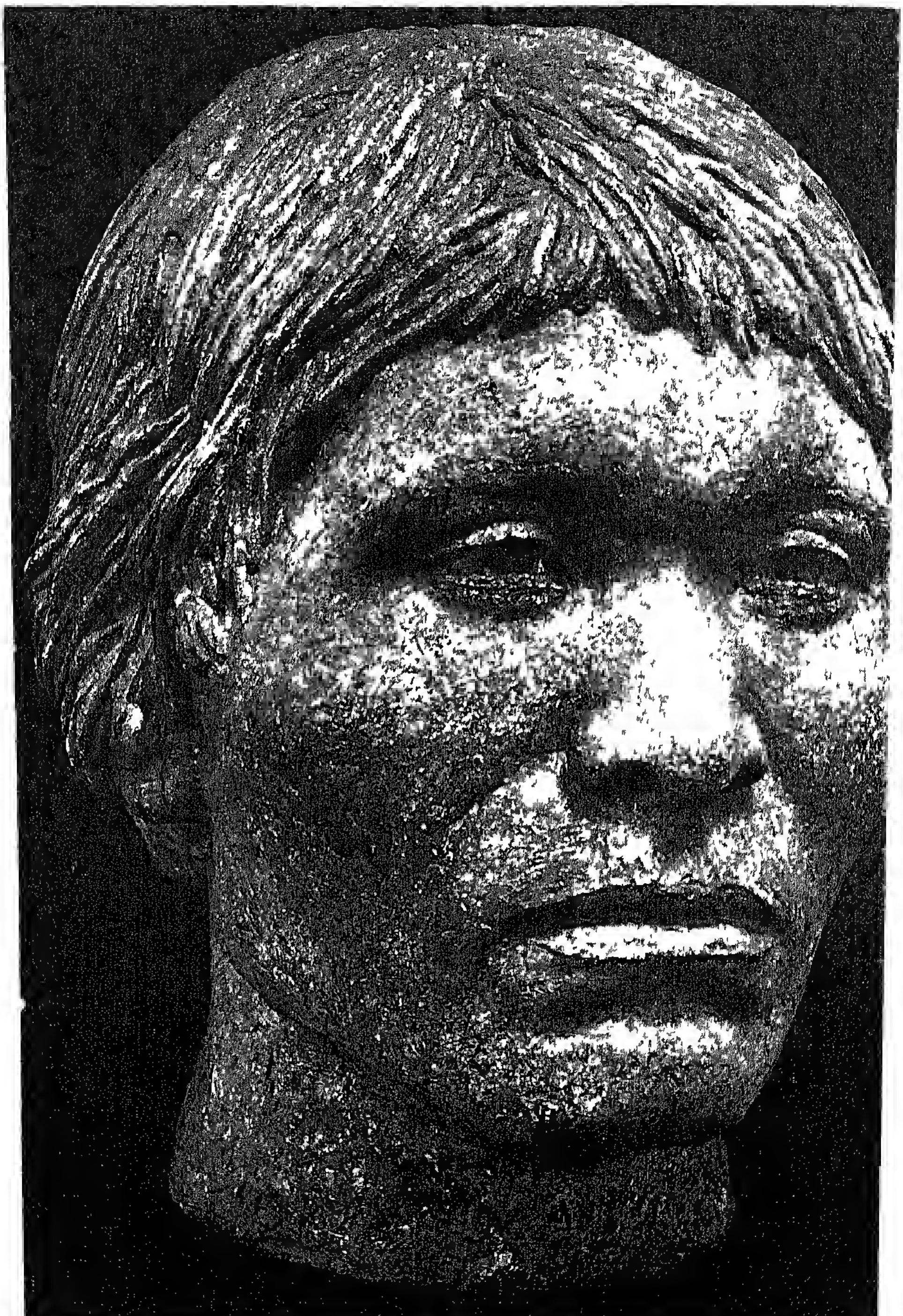
TEPEXPAN MAN



Tepexpan Man

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TEPEXPAN MAN

HELMUT DE TERRA
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HELMUT DE TERRA

INTRODUCTION

MY Pleistocene studies in Asia and in particular of the ancient geographic conditions under which prehistoric Man developed there were cut short by the war. In casting about for a new field of study in North America, my choice fell on the Valley of Mexico because of the unique combination of geographic and cultural factors which held out great promise for a solution of the many problems concerning the Pleistocene geology and archeology on this continent. For one thing, the Valley of Mexico presents classic and complete archeologic sequences embracing the total known record of New World civilizations some of which presumably go back to the very start of civilization, or the beginning of agriculture. The geographic setting, on the other hand, with ice-covered volcanic peaks rising near a lake basin, challenges the imagination to the point where the investigator is inevitably drawn to present the story of early human history in terms of such climatic and other geographic changes as glaciated mountains and lakes may have recorded over the last geologic periods. If the results of my studies, as presented here, seem to have fulfilled some of these initial promises, it is because of the benevolent interest which The Viking Fund, Inc., of New York, has shown through two years of study. To its directors, and especially to Dr. Paul Fejos, Director of Research of the Viking Fund, I feel greatly indebted for both financial support and inspiring advice. For in a large project of this sort, new viewpoints of research appear, demanding understanding and critical appraisal, and of both Dr. Fejos has given unstintingly. Professor Ralph Linten, of Yale University, as editor of the Viking Fund Publications, has earned the gratitude of all who have contributed to this report.

The data for this report were collected in two field seasons of which the first lasted from November, 1945, to April, 1946, and the second throughout the year 1947. The first field season in Mexico was interrupted by a month's visit to Guatemala, where Dr. Alfred V. Kidder of the Carnegie Institution of Washington most kindly provided me with much pertinent information. During the same season, excursions were made to Oaxaca, Puebla, the Gulf Coast near Veracruz, Acapulco, Michoacan and San Luis Potosi, partly for the sake of testing the regional validity of the stratigraphic results gained in the Valley of Mexico, and partly to investigate in a purely exploratory manner certain sites that had been called to my attention by my Mexican colleagues. In April, 1946, the month was spent with difficult explorations on the partly glaciated slopes of the high volcanos Ixtaccíhuatl and Popocatepetl. Information gathered there was made possible

through generous assistance rendered by the Director of the Empresa Hidro-Electrica de los Volcanes, Ing. Pascual Ortiz Rubio and by Ing. Viscayno.

The research methods employed throughout this field work were principally geological inasmuch as this is the now recognized science by means of which ancient culture sequences can be allocated in their proper time sequence.

One new method, however, assisted greatly in the location of one of the major discoveries of anthropologic interest, the find of the Tepexpan Man, the most completely preserved fossil man so far encountered in North or Central America. Dr. Hans Lundberg, of Toronto, Canada, conducted the geophysical fieldwork and he deserves much credit for the unique and successful application of an electrical device to the detection of buried fossil remains.

The map of Tepexpan and vicinity is the combined result of my own geologic survey with the topographic work of Mr. Kenneth Segerstrom, Topographic Engineer of the U. S. Geologic Survey, whose skill was made available through the courtesy of Mr. Carl Fries, of the American Embassy branch of the U. S. Geological Survey in Mexico City. Other data on elevations, place names and topography were gathered under my direction by Ing. Marciano Moreno who did levelling work at many of the sites described hereunder. For the high volcanos other topographic data were made available through the aforementioned Empresa Hidro-Electrica and through the Secretaria de Recursos Hidraulicos of the Mexican Government.

Much credit for the successful execution of my field work is due to the co-operation of the Mexican institutions, notably of the Instituto Nacional de Geología, and the Museo Nacional, the Instituto de Antropología e Historia and the Secretaría de Recursos Hidraulicos. Of the many who interested themselves and helped in my project, I should like to thank Ing. Ezequiel Ordoñez, Ing. Ricardo Monges Lopez, Ing. Luis Blasquez L., Sr. Jésus Portillo Martinez and Ing. Ricardo Martinez Ruiz; and above all, Ing. A. R. V. Arellano who accompanied me on various occasions and who put useful information at my disposal.

The Director of the Museo Nacional, Dr. Daniel Rubin F. de la Borbolla, earned special thanks by putting a laboratory room in the Museum at my disposal. He also called my attention to some promising sites in the states of Guanajuato, Michaocan and San Luis Potosí and was instrumental in securing expert advice on the proper anatomical study of the Tepexpan Man remains. Thanks to his efforts, the Mexican Government was persuaded to permit a temporary transfer of the fossil to the Smithsonian Institution in Washington, D C., where its reconstruction was accomplished by Dr. Javier Romero and Dr. Dale T. Stewart. In the same Institution my friend, the sculptor Leo Steppat, executed the fine plastic reconstruction whose picture appears in the frontispiece. The manner combining science and ingenuity in which Steppat carried out this task deserves much credit.

Useful assistance was rendered in the execution of the geophysical work by Ing. de la O. Carreño, Director of the Geological Section of the Secretaría de

Recursos Hidraulicos Several members of this distinguished Government institution furnished valuable information, particularly Dr. Paul Waitz, Ing. R. Ramos Robles and Dr. M. Maldonado-Koerdell. To all these colleagues I wish to express my sincerest thanks.

In the summer of 1947, my friend and colleague, Dr. Kirk Bryan of Harvard University, visited Mexico and on several joint field trips we discussed many of the aspects of soil geology and stratigraphy presented in the Valley of Mexico. Equally appreciated is the visit which Doctors F. Weidenreich and Dale T. Stewart paid to the site and to the fossil remains of Tepexpan Man.

While the stratigraphy was worked out through geologic methods, paleontologic evidence collected by me was not entirely neglected as shown by the identifications kindly rendered by Doctors Paul McGrew of the University of Wyoming, Claude W. Hibbard of the University of Michigan and Paul S. Conger of the Smithsonian Institution. The fossil vertebrate remains and diatoms are kept in the Instituto Nacional de Geología in Mexico City while the artifacts have become the property of the Museo Nacional.

I am very grateful to my wife for her help in the preparation of the manuscript. Miss Irmgard Groth of Mexico City contributed many of the photographs of artifacts. Señor Juan Guzman kindly permitted me to use a few of his pictures from Tepexpan.

The final shape of this report is designed especially for anthropologists, which accounts for the relative brevity of the geologic part. Much remains to be described in greater detail, especially the glaciologic data and others pertaining to the Late Quaternary history of the Valley of Mexico.

GEOGRAPHIC ENVIRONMENT

NO other landscape in Mexico rivals in grandeur and diversity of geographic expression the southernmost of the plateau basins commonly known as the "Valley of Mexico." Here the grimness of the volcanic landscape is matched by an austere grandeur of ice-covered peaks surmounting lakes whose waters mirrored a cavalcade of civilizations embracing the total known time span of human occupancy in the New World. Its subtropical climate, tempered by high elevation above sea level (2,240 m), imparts to its volcanic soils a fertility challenging all kinds of human enterprise. And since it is the southern apex of an elongated triangle of plateau basins known as the Mesa Central, the Valley has time and again played the role of a geographic theatre for many important cultural movements.

Physiographically, the valley is a basin of elliptical shape, with north-south orientation. Built of volcanic rocks, a sporadic mantle of alluvial formations covers its southwestern flanks, its bottom an intertwining pattern of residual lakes, mudflats and tree-lined settlements. An areal picture will disclose a landscape devoid of abrupt relief, with marginal hills and volcanic cones and gently sloping surfaces that seem to obscure the erstwhile violence of volcanic action. Individual mountain groups carry distinctive names, such as the Santa Catarina Range in the South, a row of cinder cones and lava flows slicing the Chalco basin off the main valley (Fig. 1). South of the city lies the Pedregal lava field, while further west the suburbs Tacubaya and Iomas lie nestled against the forested lava slopes of Ajusco (3,940 m) and Monte Alta (3,500 m). These two mountains form the western half of a horseshoe-like mountain scenery whose southern portion makes the divide with the valley basin of Cuernavaca (1,543 m) and whose eastern portion culminates in the high volcanos Popocatepetl and Iztaccíhuatl. Of these only Popocatepetl presents a rather typical volcanic cone, a faint plume of gases rising from its deep crater and oftentimes drifting across the lone snow field on the northern slope. Its last eruption in the years 1920 and 1921 scattered dark ashes over the neighboring but extinct Iztaccíhuatl (5,286 m), "the sleeping beauty" of the Aztecs whose firn cap is one of the most celebrated of sceneries in Mexico. The total surface covered by ice measures some 14 square kilometers and extends down to 4,600 m above sea level from where moraines and ice scored rock reach down to 3,200 m. During the winter snow blankets both volcanic mountains for many weeks, though freezing temperatures rarely touch the adjoining valleys.

On the mountain flanks small caves and rock shelters are occasionally seen either in solid ancient lava or on cinder cones, like at Tepexpan, and in massive volcanic breccias as near Teotihuacan. Only a few of these came under closer scrutiny

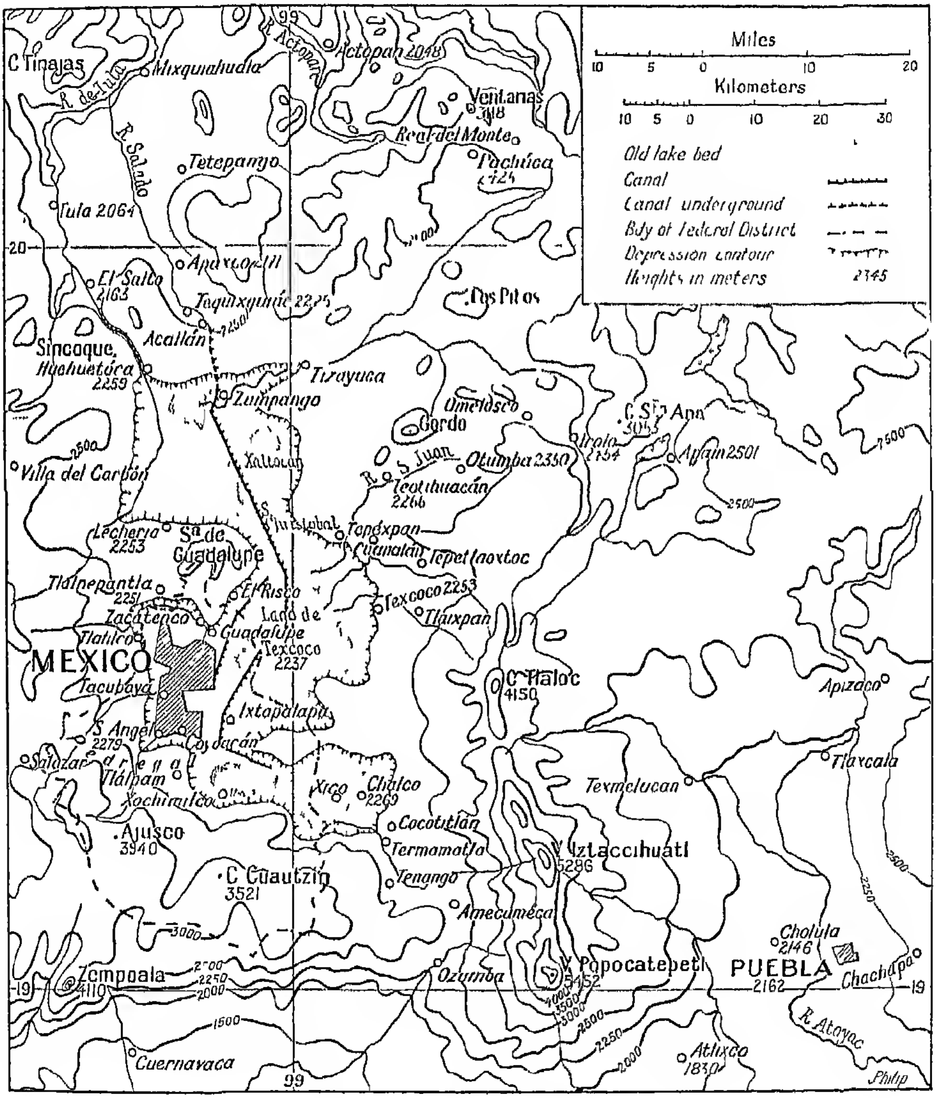

FIG. 1. THE VALLEY OF MEXICO

during my studies and except for those situated in breccias, none was found to contain cave refuse and soil sufficiently thick to raise expectations of ancient culture sequences. The few investigated showed brief occupation by ancient peoples leaving

remnants of their pottery and figurines and stone tools of the Teotihuacan or Aztec type.

Generally these mountain slopes are mantled by brown or gray-yellowish "tepetate," a term quite loosely applied to a diverse sequence of weathered tuff, windblown and alluvial soils. Their volcanic ingredients make them fertile to such a degree that the farmers can go on planting their maize, bean or barley year after year without being bothered much by loss of mineral substance. And wherever stony soils occur, or caliche litters the surface with its hard chalky colored rocks, the mague plant will always provide fibre and juices, and the giant cactus will yield the juicy tuna fruit. Thus there would seem to have been on these valley flanks from time immemorial a minimum of fertility lacking in many of the northern regions.

But it is the valley which provides on well-watered ground an almost ideal habitat for the farmer. In fact here corn and bean fields merge in marginal lake marshes, as at Xochimilco, with vegetable and flower gardens. Beginning with the Aztec period, population pressure induced peoples to convert such marshland into fertile ground by artificially raising its level in regular patches lined by willow trees and separated by narrow waterways. Even in pre-Aztec times mounds were built along the lake shores, the so-called "tlateles" where fishing and hunting provided welcome supplements for the starchy diet.

Not much is left of the old lakes; in fact, over the last 220 years the total water surface was reduced from 1,600 square kilometers to about 321. When Cortés came in 1520, he still saw practically the entire valley covered by shallow water from which rose island-like the Aztec capital of Tenochtitlan. But impressive drainage works were already begun in the 17th century by canal construction across the low northwestern divide into the Nochistongo and more recently into the Acatlan valleys. In 1861[1] there still existed six separate lakes of which Lake Texcoco was the largest with a total surface of some 51,000 acres. It is necessary to realize the large extent of this lake in relatively recent times and the occasional fluctuations to which it was subject due to shallowness and seasonal floods of its inflowing streams, for at present only a small remnant exists, exploited already for the extraction of mineral salts. That Lake Texcoco with its water fowl, its fish, crustaceous and amphibian life had up till recently attracted the ever changing invaders is clearly attested by so many ancient settlements whose refuse piles litter its former shores. In fact one might say that it was the lake which acted from earliest times as a sort of magnet, first for the big game hunters of the late Ice Age who undoubtedly saw their chance in lagoons where large beasts became mired; then for the others who, still ignorant of farming practices, extracted from it protein food as a necessary supplement to their predominantly vegetable diet. It is

[1] *Memoria Historica* (Mexico, D.F., 1902).

conceivable that the larger lake fluctuations in prehistoric times even affected the living standards of those early nomads to the point where drastic changes in accustomed diet made for migratory movements. The dry climatic phase of the Early Recent epoch and the succeeding moist phase may have made their respective impacts on such ancient societies At present the lake plays a minor role in the life of the people due partly to changed living standards and in no small degree also to land reclamation measures which have transformed the old lake beds into a dustbowl. In consequence thereof the city and its environs are quite often enveloped in dust storms of such intensity that the landscape is veiled for days on end, a spectacle which has its special interest to the student of prehistory if only for conjuring up past times when climate was drier and dust from the desiccated lake beds mingled with the volcanic ash to form tepetate soils.

This restlessness of the soil during the dry winter season is occasionally augmented by earth tremors which, while not of a destructive type, nevertheless remind one of the data on basin subsidence recently assembled by Cuevas.[2] The valley floor undergoes sinking especially in the city itself, but to a lesser degree also in outlying districts. Displacement of bench marks at some localities amount to one or two meters during the last forty or thirty years.

On this mobile volcanic soil climate imparts a fairly lugubrious influence with limited variations of temperature and rainfall as far as the valley itself is concerned (588 mm per year). During the summer months moisture-laden winds drift in from the Gulf Coast and thunderstorms resulting from convectional currents drench the countryside with sufficient rain during the growing season. During the winter the "nortes" or northers bring showers and also snowfall on the high mountains nearby, a condition regulated by air pressure distribution between the elevated part of the American Southwest and the Gulf of Mexico. This relationship with the climate of the northern regions already explains why ancient climatic changes in the Valley of Mexico so closely resemble those found recorded in the southern Rocky Mountains or the Sierras to the west. The changes induced by the Ice Age climate in North America quite obviously are reflected in the geologic events described in the succeeding chapters. On this climatic relationship are to be based many of the conclusions drawn from the alternation of pluvial and dry climate soils, of stream terraces and erosion phases, of glacial movements and lake changes which form a kind of convenient interpunctuation for the unwritten though geologically documented prehistory of the region.

Such changes of climate must have greatly affected the geographic distribution of plant zones which range from alpine meadows and mixed needle and broad leaf forests to scrub-grasslands where agave, yucca, opuntia strive with scattered

[2] Jose A. Cuevas, *El hundimiento de la capital de la republica* (Boletin Societas Mexicana de Geografia y Estadistica, vol. 61, 310-339, 1946).

stands of trees like eucalyptus, pirul (*Schinus molle*) acacia, mimosa. The mixed forest with the stately Taxodium (*Sabios*), ocote pine and oyamel (*Abies religiosa*) has now largely disappeared from the valley except for Chapultepec Park in Mexico City where one may wander and imagine this to be an artificial relic of a forest which a moister climate could have spread over what now are parched hills.

Now the particular section of the valley to which so much of my studies were devoted, Tepexpan and its environs, has a geographic character all its own in that here the volcanic rock projects in form of a low hill into the lake flats carving *from them a lagoon predestined to witness one of the earliest of human habitations.* From the hills nearby, one can overlook the valley and see it as a grand stage with mountain after mountain dissecting its margins, arresting both by its openness and its strict topographic limitation, where peoples had time and again come to settle and to create societies whose cultural monuments have survived the ages like reminders of the imperishable heritage which is mankind's best privilege.

GEOLOGIC HISTORY OF THE TEPEXPAN REGION

THE CHOICE OF THE REGION

THE concept that Early Man in North America had migrated on the trail of mammoth and bison herds at the close of the Ice Age is so widely recognized that it makes obvious the author's selection of a terrain known for its wealth of mammoth remains. Shortly after my arrival in Mexico in November, 1945, I happened to look over the lake flats near Tepexpan from where several fossil elephant remains had previously been uncovered and subsequently placed on exhibition in the Instituto Nacional de Geología in the City of Mexico. Although I was then unaware of the fact that these fossils had been located at five different localities in the course of road construction along the highway to Acolman and Teotihuacan,[8] I suspected that the local villagers might know of some additional finds. Thus I learned from the construction engineer of the new Hospital for Chronic Diseases at Tepexpan, Sr. Carlos de la Llana, that a few months prior to my visit, his laborers had come across the skull of a fossil elephant. It had been found close to the southern corner of the hospital wall below the caliche formation, and only some 10 yards distant from the place where another skeleton of elephant had previously been discovered (Fig. 2).

The previous finds had been made between kilometers 3 and 6 along the same highway and the new site brought the number to six localities over an area of three square kilometers.* A seventh locality was suggested by a peon from Totolzingo who claimed to have encountered so many fossil bones in his well that he had sold the whole lot for fertilizer. To me there was little doubt that the lake flats adjoining the low hill slopes near Tepexpan had been the scene of a prehistoric drama involving the extinction of an entire herd of elephants and perchance of prehistoric man. Accordingly I began to investigate the geology of the region.

One of the results of these preliminary studies was the detection of ancient beach gravels on the hill slopes northwest of Tepexpan (Fig. 2), a geologic rarity

[8] Enrique D. Lozaho, *Los restos fósiles de "Elephas"* (Anales del Instituto Geologico de Mexico, vol. 2, 201-202, 1925).

* In this report, the metric system was employed for surface measures and elevations because of its usage in Mexico and on the topographic maps of this report. In geologic sections, however, thicknesses are given in inches to facilitate reading for English speaking readers.

in the Valley of Mexico where evidence for fluctuations of a prehistoric lake had been suspected but never clearly seen. These beaches had formed on the hill slopes and seemed to augur well for the presence of prehistoric remains.

During my temporary absence from Mexico, in the second half of the year 1946, the digging of a long ditch by the hospital authorities brought to light two additional fossil elephant skulls and other skeletal remains. These were excavated by Ing. A. R. V. Arellano of the Instituto de Geología who reported[4] the find of a small waste flake of obsidian below one of the skulls This discovery confirmed my contention of the contemporaneousness of Early Man with the late Pleistocene mammal fauna in the Valley of Mexico, an observation which had resulted previously from my scattered finds of artifacts in the fossiliferous Becerra sandy gravels at Tequixquiac and San Francisco Mazápan.[5]

With this unique concentration of geologic, paleontologic and archeologic data near Tepexpan, a special study project was inaugurated which resulted on February 22, 1947, in the discovery of a fossil human skeleton in a swamp deposit of late Upper Pleistocene age. The geophysical method employed by Dr. Hans Lundberg in detecting this fossil will be presently described.

In preparation for these detailed investigations, a topographic map was made by Mr. Kenneth Segerstrom, topographic engineer of the U. S. Geological Survey Section of the U. S. Embassy in Mexico City. It was executed on a scale of 1:5,000 with one meter contours. This map of Tepexpan is attached to this report.

GENERAL ASPECTS OF THE TEPEXPAN REGION

The village of Tepexpan[6] lies at the base and on the promontory of a basaltic lava flow which projects from an old volcanic cone into the valley basin. The highway to the pyramids of Teotihuacan skirts this promontory seven kilometers distant from Route 1 (Laredo highway) or some 34 kilometers from Mexico City. The flanks of the valley basin are formed by two hills, Cerro de Tlalhuilco and Cerro de Chiconautla (Pl. I), the latter forming a prominent mountain at the foot of which lie the small but ancient settlements: Chiconautla, Venta de Carpio, Atlauzingo, Totolzingo. These volcanic hills are built of volcanic breccia, basalt

[4] A. R. V. Arellano, *Datos géologicos sobre la antiquedad del hombre en la cuenca de México* (Memoria del Segundo Congreso, vol. 5, 213-219, 1946).

[5] H. de Terra, *New Evidence for the Antiquity of Early Man in Mexico* (Revista Mexicana de Estudios Antropologias, vol. 8, 69-88, 1946).

[6] Pronounced Tepéshpan, a word from the Nahuatl language meaning "a place above the rock" (see Zelia Nutall, *Official Reports,* Peabody Museum papers, vol. 11, No. 2, 1926), and referring to the basalt hill which projects here into the valley. It was a prosperous farming community when Cortés came in 1519 and before the Conquest was an independent town of the Chichimecs.

ash and lava flows which form the oldest of the geologic formations encountered in this vicinity. The lava flows appear at the base of these hills and project basinward, forming distinct ledges and cliffs, some 8-23 m above the old lake flats

These volcanic slopes are covered by a variety of alluvial, soil and lake deposits which may be classified into various substages (Fig 3 and Table 1).

Vertebrate fossils encountered in the older alluvium (Becerra) suggest an Upper Pleistocene age, and it is probable that the still older or Tacubaya member of this sequence also belongs to this age. The terms Tacubaya and Becerra had previously been given to certain alluvial deposits described first by Bryan[7] and Arellano[8] from the Becerra barranca and Tacubaya township in the Lomas section southwest of Mexico City. The term El Risco, on the other hand, was given by me[9] to fluvio-lacustrine sands underlying younger lake deposits at El Risco, a locality north of the limits of the Federal District. Each of these stratigraphic units, or substages, are separated from each other by caliche, a fossil pedocal type of soil present also on top of the El Risco sand.

Several small arroyos exist on the slopes between Totolzingo and Tepexpan which expose these formations. The Becerra alluvium is heavily calichized on top and extends from contours 2,320 m down to 2,265 m at which level it is overlain by gray sand with gravel layers and tuff.

These deposits dip under a sheet of gray tuffaceous earth showing faint layering and containing rolled caliche fragments. The gray sand, hereunder called El Risco, contains gravel layers, one at 2,263-2,265 m, the other at 2,257-2,258 m above sea level. These gravels have been traced along the slope westward over a distance of three kilometers and will presently be described as the former shores of a prehistoric lake which followed upon the deposition of the older Becerra alluvium.

While much of the older deposits have been either stripped by subsequent slope wash or covered by younger formations, the latest lacustrine members of the Upper Pleistocene are well preserved under the adjoining lake flats (Pl. 1, 2, A). These present a gently sloping surface from contours 2,247 to 2,241 m, occupied by maize fields and pastures. The El Risco sandy clay can be seen in ditches especially in the long drainage ditch which extends over 1,600 m north of the highway (Fig. 2). In this ditch were found the two fossil elephants which prompted the search for fossil man. The latter was finally located in El Risco clay 20 m north of the long ditch. Beyond the map limits the lake flats continue for three kilometers where, at a level of 2,238 m, marshy ground delineates the residual Lake Texcoco.

[7] K. Bryan, *Comentario e intento de correlación con la cronologia glacial* (Memoria del Segundo Congreso, 1946).

[8] A.R.V. Arrellano, *Datos geologicos* (1946).

[9] H. de Terra, *New Evidence for the Antiquity of Early Man in Mexico* (1946).

GEOLOGIC SEQUENCE AT TEPEXPAN

OLDER VOLCANICS

As in most parts of the valley, lava and associated volcanic breccias underlie the sedimentary sequence (Fig. 3, b). Basalt lava flow appears in the upper part of the arroyos which have been cut sufficiently deep to expose the volcanic floor, as north of Totolzingo or on the surface at Tepexpan and along the slopes west of the former village. Unlike the Pedregal lava, south of Mexico City, this basalt is rarely scoriaceous. Prior to the deposition of the Upper Pleistocene, the lava was eroded, small valleys were cut into it and bluffs must have existed along the basinward edge of the lava sheets. This type of relief must in the course of time have become more accentuated because of the progressive sinking of the valley basin.

The slopes of the two volcanic hills are strewn with volcanic bombs and lava fragments, testifying to the explosive force responsible also for the accumulation of breccias and ash of which the two hills, Cerro de Chiconautla and Tlalhuilco, largely consist. Their structure is such as to suggest an older volcanic phase with outpourings of basaltic lava clearly antedating the Upper Pleistocene and a younger explosive phase to which I attribute the pumice, ash and little consolidated breccias. This may account for preservation of the crater shape of Tlalhuiclo or for the loose consistency of ash and pumice beds and the abundance of volcanic bombs around its slopes. The latter are quite fresh but apparently have been affected by caliche formation. That volcanism was still active in this neighborhood in pre-conquest days is indicated by the Castañeda report[10] which records the existence of the "mountain of fire" (Tlahuilquitl) from which light issued at night. Its position is given as a quarter of a league distant from Tepexpan, in the confines of Texcoco, near the town of Tequizistlan "very close to the lagoon" and south of Tepexpan.

UPPER PLEISTOCENE SEQUENCE

Tacubaya Formation. The Tacubaya substage is recorded by a thin mantle of brown or deep ochre colored, gritty clay resting on basalt whose surface is equally stained. Exposures are found in the arroyo north of the westernmost outskirts of Totolzingo, at contour 2,255 m and upward (Pl. 4, c). In this arroyo the brown clay reaches to about 2,275 m where it is replaced by calichized younger clays and silts of the Becerra formation. This overlap of younger clays over Tacubaya suggests an erosion interval during which much of the brown clay was washed away. In fact, none of the brown clay was found on the adjoining slopes but it reappears again in a small quarry west of Totolzingo at a level of 2,251 m.

With Bryan[11] I assume that this brown clay is derived from tuff and that it is the weathering product of a type of climate somewhat rainier than the present.

[10] Zelia Nuttall, *Official Reports* (Peabody Museum Papers, vol. 11, no. 2, 1926), 74.

[11] K. Bryan, *Comentario e intento* (1946).

Its limonitic stain, the disintegration of its constituents, the clay matrix are suggestive of a fossil soil of the pedalfer type. There is here no indication of river or lake deposition and for this reason it is impossible to tell at what level the old lake stood at the time of its formation. However, there are other localities in the valley which permit of better interpretation of such geographic changes.

Interformational Caliche I. In the above named locality, as also in an arroyo which descends northeast of the village of Totolzingo, the Tacubaya clay is overlain by a thin caliche, a couple of inches thick (not indicated on Fig. 3). It appears along the disconformity with the old Becerra alluvium and therefore marks a clear-cut break in the petrogenesis of the sequence. Bryan and Arellano have observed a similar interformational caliche in the southwestern part of the valley and have interpreted it as suggestive of a climatic change, a dry interval to be sure, which succeeded the pluvial Tacubaya substage. There is little in this vicinity to add or criticize as far as this interpretation is concerned. That caliche required a relatively dry climate is too obvious to warrant further discussion but what is of interest here is its appearance along the disconformity. It means that the drier climate brought about erosion and gullying and this, in turn, meant a low lake level, possibly as low as the present artificially induced retreat of Lake Texcoco.

Old Becerra Alluvium. More completely represented than the preceding stage, the Becerra is recorded by a variety of sediments which reflect the interplay of such geologic factors as volcanism, stream deposition and soil formation. Its deposits lie on the slope, hence the variety of factors which entered into its formation. Four units can be distinguished: clay-silts of light gray to yellowish color, gray and pinkish silts, gravely sands and yellow loessial tuff. Hereunder this sequence is designated as Old Becerra alluvium in contrast to the younger Becerra substage which at other places, near Tequixquiac and in the San Juan valley forms distinct terrace or alluvial fills (Fig. 8). These occupy the same structural position in relation to the Old Becerra alluvium as the El Risco sand holds near Totolzingo.

Top

gray sand with gravel layers (El Risco)	9-12 feet
disconformity	
yellowish loessial tuff	4 feet
banded silt and clay calichized on top	11 feet
sandy marl and clay with gravel lenses	9 feet
pink gravel and laminated sand	8 feet
Tacubaya brown gritty clay	2 feet
Basalt lava flow	

In the arroyo lying 800 m northeast from here a similar sequence was seen though banding through buff soil zones is here more pronounced in the upper clay. Below this lies a 4-inch layer of light gray indurated tuffaceous sand with

stratified thin gravel and clay below. The gravel is composed of small clay pellets and of weathered basalt fragments suggestive of detritus which accumulated on a gently sloping surface through sporadic stream action. Lenses of laminated silt alternating with fine sand indicate stagnating water deposition, possibly in a lagoon. Vegetation suggestive of such conditions is indicated by root canals in the banded clays.

The indurated volcanic sand differs from the upper (El Risco) sand by its hardness and finer texture. It may have been one of the sources for the El Risco beach sands. The total thickness of the Becerra alluvium sequence ranges in these sections from 28 to 32 feet. Vertebrate remains, chiefly isolated bones of bison and elephant, were encountered only in the upper calichized layers which overlap upslope some of the older deposits. At about contour 2,300 m, banded clays as well as pink sands and gravels get pinched out between calichized clay and underlying Tacubaya clay

Interformational Caliche, II. The loessial layer as well as the underlying silt and clay are strongly calichized with single caliche bands and caliche filled cracks penetrating to a depth of six feet (Pl. 4, B; 4, A, C). Its formation must have preceded deposition of the overlying El Risco sand because of the caliche clay pebbles contained therein. For this reason it is to be assumed that a dry substage followed upon deposition of the Old Becerra alluvium. Sections in other regions (Figs. 8 and 10) disclose a similar dry interval.

El Risco Sand and Clay. The younger sandy member of the Upper Pleistocene Becerra formation appears between contours 2,265 and 2,249 m and is best exposed at the intersection of the Totolzingo arroyo with the old Teotihuacan road (Pl. 6, B). Other exposures are found 200 m north of the cemetery of Totolzingo and in the adjacent sand pits. This sand is of light gray color, somewhat speckled by dark minerals and containing gravel layers and fossil vertebrates.

This sand rests against the older Becerra alluvium. Its distribution along the slope over a distance of four kilometers is quite independent of the local topography and suggestive of sandflats at the shore of a lake. The pebble composition reflects the structure of the old shore inasmuch as indurated Becerra clay, caliche, basalt are prominently represented. Average size of the rolled pebbles is 2-3 inches, many of them being coated with lime, probably evaporated along the shore. Chief constituents of the sand are volcanic glass, ferro-magnesian minerals, basalt, limonite and calichized Becerra clay. Cross-bedding was observed in one of the sandpits. Significant is the overlap of the gravel at 2,258 m over yellowish loessial tuff of Old Becerra age, some 5 m north of the intersection between the Totolzingo arroyo and the old Teotihuacan road. Here the gravel dips 10 degrees basinward over a stretch of 4 m and flattens again to a dip of three degrees (Pl. 6, B). I hold this to be a natural dipslope of the lower El Risco beach. From contour 2,257 m downward the sand turns gradually into a fine diatomaceous sand which reappears below the lake flats.

Of considerable interest for the climatic history of the region are certain fossil vertebrate remains which I collected from the Becerra and El Risco deposits. The sandpits near Totolzingo yielded teeth of horse and deer and bones of elephant and turtle. The type of vegetation required for sustenance of these animals may best be envisioned as parkland adjoining lake shores with swampy lagoons. This means that rainfall must have been greatly in access of what it is today, an assumption in accord with the nature of the sediments themselves, especially the occurrence of shore gravels in the El Risco. The presence of so much sand accumulated on the basinward slope of the Becerra is unthinkable without a complete change in the sedimentation process of the basin from alluvial to a fluvio-lacustrine deposition. The discussion of other sections involving El Risco sand will presently show how relatively uniform is its composition and grain size. The accumulation of so much sand in a region devoid of quartz-bearing rocks seems puzzling indeed. Yet there are two primary sources, the tuffaceous sand and the gravelly portions of the Becerra. Their presence in other parts of the valley assures a vast supply which required an agency making for basinwide and fairly even distribution. Only lake currents and the ever present motion of shore waves could have accomplished this.

Before discussing the volcanic deposits overlying the sand, it is necessary to evaluate the meaning of the beach gravels.

Lake Level Changes. The Tepexpan region is obviously too small an area to justify an exhaustive treatment of this problem considering the large size of the basin. Yet at no other place visited by me is the evidence for former lake changes so clearly documented as here.

The Tacubaya clay in this region is so poorly developed that no paleoclimatologic data are gained from it except that its derivation from a pedalfer type of soil required more vegetation and therefore more rainfall than prevails nowadays. The question as to a rise of the lake during this stage will be discussed elsewhere when additional geologic data are presented. As for the Becerra alluvium the only deposit offering criteria are banded buff clays with root canals. Swampy ground must have existed then and this in itself required flat playa-like surfaces which could not have been far from an actual lake. While the main waterbody could have lain at some distance from the ground where these clays are now exposed, the surface must have been flat or nearly so. In other words, the present slope did not exist then. Considering that the banded clays now lie at contours 2,280 and 2,290 m and that the Becerra alluvium dips below the El Risco sand at contour 2,257 m, it would seem reasonable to make basin subsidence and warping responsible for such a position. Such subsidence becomes evident from a variety of observations.

In the introductory chapter mention was already made of sinking tendencies geodetically proven by lowering of bench marks within and outside of the Mexico City limits. Even the bench mark at Tepexpan has suffered slight downward displacement since the close of the last century. While it is at present impossible to

compute a standard rate of sinking, an amount of 20 m reckoned from the time of the Becerra alluvium would not be excessive. If this figure is added to the lake level as it existed in Spanish Colonial times (2,240 m), the local base level of erosion, in Becerra time, must have been at 2,260 m above present sea level. In such a case the banded clays with root canals would still have required a water table lying some ten to twenty meters higher than the valley floor assumed for that substage. This figure still is 25 m below the top level at which El Risco sand was encountered on the divide of Acatlan (Fig. 1). While the latter region has suffered uplift at a rate greater than the movement assumed for the Tepexpan region, the high position of water-laid deposits in this locality may well indicate a lake level higher than during the succeeding El Risco substage.

Between the deposition of the Becerra alluvium and the El Risco, fine yellowish loessial deposits were formed on the basinward slope. This phase must have inaugurated the dry interval indicated by the second interformational caliche and by the erosional disconformity between the El Risco and older alluvium. Caliche soils developed on the slopes, especially on the Becerra clays and silts.

Subsequently, a new rainier interval caused the lake to rise and to form the uppermost of the El Risco beaches (Fig. 3, I). Considering that this beach lies at contour 2,265 m against a slope steepened by basin subsidence, an absolute rise of lake level by some ten meters can be postulated only if the elevation of the basin floor above present sea level during the preceding dry interval was then at 2,255 m or 15 m above that of the Colonial period, an assumption justifiable by the above-mentioned consideration of the basin subsidence. As the second of the El Risco beaches lies at contours 2,257-2,258 m, the lake must have dropped by 7-8 m. This drop may have been caused by basin subsidence forcing the water off the slopes, and to collect in the deepened valley center. The shore gravels of beaches are well exposed in an arroyo north of Totolzingo, (Pl. 6, B). A third and lowest El Risco beach is not recorded in this region though it is well exposed some twenty kilometers south at El Risco (Fig. 1).

YOUNGER VOLCANICS

While the lake was shrinking, showers of ash and pumice occurred, forming a mantle of gray-yellowish deposits over El Risco sand (VA in Fig. 3). Its thickness varies from five to three feet in the slope sections. Part of these pumice showers fell on the marginal swamp of the lake so that the El Risco brown to buff colored clay contains thin lenses of this material (Fig. 7, B). The origin of these volcanic products may be sought for in volcanic eruptions of the volcano Popocatepetl or in eruptions of the Santa Catarina range some forty-five kilometers distant from our region.

The stratigraphic position of these younger volcanics is evident from their presence beneath caliche in the lake flat sections as well as under the tuffaceous dark

earth hereunder called the Totolzingo. Climate must then have been wetter than in the succeeding phase because of the slight limonitic stain encountered in the ash-pumice deposits. In other words, these ash falls occurred at the closing phase of the last Pluvial when vegetation was still sufficient to produce pedalfer type of soils.

Lacustrine Closing Phase of the El Risco. Beneath the present lake flats the lacustrine facies is represented by brown to buff colored diatomaceous clay and sand (Fig. 4). The sandy clay (Figs. 4 and 7, layer 5) is full of root canals suggestive of vegetation and its thickness varies from three to eighteen inches. Blackish muck layers appear in the central portion of the former lagoon and lenses of pumice occupy the uppermost stratum. Pumice floated on the water of the shallow lake prior to the succeeding dry phase and the caliche formation. It is to be assumed that the El Risco clay and sand were somewhat reduced in thickness when the ground dried up and caliche began to form.

This closing phase of the El Risco witnessed the extinction of a herd of elephants (*Archidiscodon imperator*) of which no less than four specimens, in various states of preservation, were found within the limits of the map. The position of one of these fossils as described by Arellano[12] leaves no doubt but that they waded into a swampy lagoon of the old lake where they were trapped in the soft marsh. That Early Man was involved in this dramatic event may be assumed from the find of a fossil human skeleton which climaxed the geological studies at Tepexpan. Detailed descriptions of the sections involving this interesting scene of prehistoric life will be given hereunder.

RECENT FORMATIONS

Of these we may distinguish caliche, Totolzingo tuffaceous earth, lacustrine shell-bearing marls and muck, Zacatenco beach gravel and silt, and sandy clay soil with ceramic remains.

Interformational Caliche III. Beneath the lake flats it forms a more or less solid sheet from four to eight inches thick lying between El Risco clay or sand and younger marsh and soil deposits (Pl. 3, Figs. 4 and 5). On the lakeward margin, caliche had undergone leaching through subsequent periodic as well as seasonal fluctuations of lake level, of groundwater and surface weathering. As shown in Figs. 4 and 5, it is missing altogether over considerable areas, or if present, it is broken up in fragments with younger marsh deposits filling the cracks of the fossil soil sheet. Important is its presence, if in much reduced form, beyond the map limits way out toward present Lake Texcoco below younger lake deposits, where saline deposits precipitated themselves. Obviously the lake must have vanished or been so greatly reduced in size as to have exposed extensive dry lake flats.

[12] A.R.V. Arellano, *El elefante fósil de Tepexpan y el hombre primitivo* (Revista Mexicana de Estudias Antropologias, vol. 8, 89-94, 1946). The mammoth excavation sites of Engineer A.R.V. Arellano are marked ARV I and ARV II on the Tepexpan map.

Here the caliche is seen as a film half an inch thick between El Risco sand and younger lake formations. Beneath the lake flats, it contains notable amounts of opaline silica, splinters of feldspar and volcanic glass. Such constituents are abundant in the lenses of pumice contained in the El Risco and also in the tuffaceous and ash deposits on the adjoining slopes.

Another type of caliche occurs on the El Risco sand and ash on the slopes. Here it forms a solid crust of platy texture, from one to three inches thick, sometimes penetrating the sand to a depth of two feet (Pl. 4, B). In streambeds, thick-

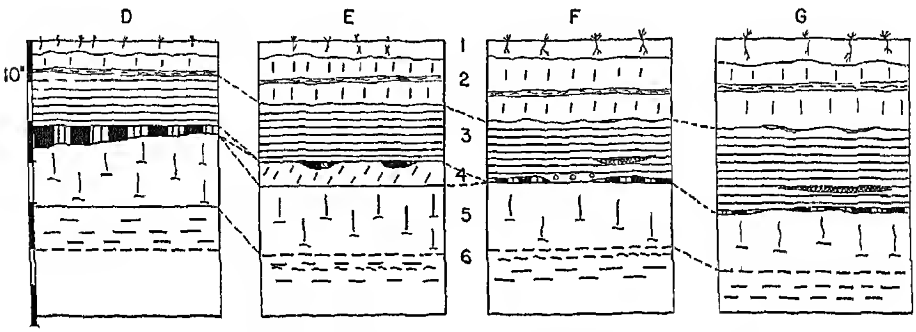

FIG. 5. SAMPLE SECTIONS IN DITCH SOUTH OF TOTOLZINGO

Section D, 35 m northeast from highway near Km. 5; Section E, 65 m east of Section D; Section F, at cross bend of ditch east of Totolzingo; Section G, 20 m east of Section F.

Layers as in Fig. 4 except 4 with lens of diatomite in Section E below caliche; lenses of peat in Layer 3 of Sections F and G; Layer 5, brown sandy clay with local lamination; Layer 6, buff and greenish clay with plant layers.

ness increases somewhat, due no doubt to occasional deposition of limy substances leached out from the calcereous sand. This observation raises the question of whether caliche is still being formed in this region. The answer must be in the negative. Stream channels lie dry for eight months of the year but are sometimes moistened by sporadic rainfall. Groundmoisture, charged with carbonate of lime, evaporates rapidly because of intense insolation and a lime crust ensues. However, in the ordinary soil where water is not concentrated as in the arroyos, lime substances formed during the dry season will be carried off in solution by precipitation so that no real caliche soil can form. North of the Valley of Mexico, as in the central mesas of the state of San Luis Potosi, with rainfall being 300 mm per year lower, caliche is still being formed on dry lake flats and sandy soils of the basins. Hence climate must have been much drier in the Valley of Mexico after formation of the El Risco sand.

Totolzingo Tuffaceous Earth. In the northwestern section of the map the El Risco sand is covered by a dark gray tuffaceous earth (Fig. 3). The best

exposures lie in the small arroyo which leads from the westernmost margin of the village Totolzingo northward to the old Teotihuacan road (Pl. 4, B). In this direction its thickness increases from seven to eleven feet. It is practically structureless except for irregular thin layers of rolled caliche pebbles and pumice in the basal portion. Essentially this is a soil sheet which developed out of Becerra (El Risco) sand and tuff but at places peaty deposits may be seen in levels upward of 2,263 m. These are obviously restricted to flat surfaces or depressions where water could have stagnated. This dark sandy soil is the only ground suitable for agriculture on the higher slopes so that ceramic remains of previous cultures are frequently found in it. However, it would be a mistake to identify this soil sheet with any of the known early farming cultures for potsherds were introduced subsequent to its formation.

The Totolzingo formation is not to be regarded as a local development because it was found at many other places in and outside of the Valley of Mexico, as in the sections near Tequixquiac and San Francisco Mazápan (Figs. 8 and 10). Its regional extension therefore justifies the assumption that it represents a stage in the geologic history of the region which is intermediate between the soils with ceramics and the caliche.

Post-Caliche Lacustrine Beds. These consist chiefly of gray shell-bearing clay and sandy marl generally characterized by white root canals. This layer is from twelve to sixteen inches thick but thins out progressively with an approach to the former lake margins. At such places where the caliche has been leached, muck and peaty deposits occur sometimes with regular matted layers of grass roots. Locally, vertical root canals penetrate into the basal caliched layer, but not further (Pl. 3, 1 layer 3). On the other hand, canals with remains of plant fibre occur in the El Risco muck. Hence one deals with two vegetation zones, one on top of the other, each of which shows a characteristic manner of decomposition. While the post-caliche root canals are stained brown or gray with walls coated by opaline silica and carbonate of lime, canals in the lower Becerra muck are black containing plant fibres. From this it would seem as if decomposition of plant matter was held up in the Becerra muck while in the upper zone it was completed to the point where root canals were filled with mineral substances dissolved probably from feldspar and volcanic glass particles. The Becerra muck was sealed off from the air first by water and then by caliche while the upper layers were subject to surface weathering induced by intermittent exposure because of water table fluctuations. Exposures in ditches and well-holes have revealed that this swamp formation of post-caliche age extends up to contour 2,245 m. From here on it lies so close to the surface that it has been incorporated in the living soil, a process which must have been greatly accelerated by tilling. On the other hand, it is obvious that this swamp must have extended at times much further back toward the slope inasmuch as beach gravels occur at contours 2,247-2,248 m.

Zacatenco Beach Gravel and Shoreline. This is the youngest of the recognizable shorelines which is commonly represented by lime-coated shingle composed of basalt, Becerra clay, pumice and caliche forming a distinct layer at contours 2,247-2,248 m. Exposures are found north of Tepexpan where a slight flattening of the slope faintly suggests the former presence of a beach. But ploughing and slopwash have obliterated much of the beach so that no continuous shoreline exists. Evaporation of shallow lake water accounts for deposition of lime (thinolite) on isolated basalt boulders or on the shingle, a feature highly diagnostic for this youngest beach.

Light colored tuffaceous sand and clays with fresh-water shells are generally associated with the beach. The Zacatenco beach receives its name after a village outside Mexico City where the late Dr. George C. Vaillant recognized it first (Pls. 4, A; 7). As pointed out in a later chapter, its stratigraphic position is not as old as Vaillant thought. In fact, it antedates the Archaic refuse beds and is therefore interpreted here as the beach of a post-glacial lake which deposited the post-caliche lake marl at a time when the Totolzingo earth was formed on the slope (Fig. 12, phase VI).

Soils with Ceramic Remains. The Caliche and Totolzingo substages of the Recent Epoch (phases VII and VI, Fig. 12) were followed in this region by a short period of erosion and lake recession. This is indicated by the presence of a disconformable contact between the post-caliche marl and younger soil containing either Archaic or Early Teotihuacan culture remains. A thin white saline layer, generally only one quarter of an inch thick, suggests drying up of the lake flat (phase V, Fig. 12). This was followed by slightly wetter conditions (phase IV) which made for deposition of a dark gray sandy soil with swamp-grass vegetation (layer 2, Figs. 4, 5 and 7, and on Pl. 3, A, B). Beneath the lake flat at Tepexpan this soil is only a few inches thick but on the left bank of the San Juan stream, near Cuanalán, east of Tepexpan, it is up to five feet thick containing burials of Archaic peoples with figurines and pottery of the Ticoman style. In the sections at Tepexpan no Archaic remains were found, probably because the ground was too swampy to permit of settlement.

A lighter colored, sandy soil with younger culture remains forms the top layer (layer 1, Figs. 4, 5 and 7, and on Pl. 3, A, B). Locally it is separated from the first ceramic soil by a disconformity and thin caliche film, suggestive of another cycle of erosion and low lake level (Fig. 12, phase III). This soil contains land snails and figurines of Early Teotihuacan to Early Aztec age and may therefore be dated as representing the first twelve hundred years of our era (phase II).

DISCOVERY OF THE TEPEXPAN MAN AND GEOLOGIC INTERPRETATION

GEOLOGIC CONSIDERATIONS

FROM the foregoing description of the geologic history it is understandable why the preliminary studies provided an ideal incentive for the search of early human remains. The combination of a lagoon environment on the edge of a lake, shrinking under the impact of climatic change, and the discovery of large extinct mammals in prehistoric swamp deposits presented such ideal conditions as to warrant an organized search for fossil human remains. The prospects of locating them appeared especially good after the first artifacts had been found in Becerra sediments both at one of the mammoth sites near Tepexpan as well as at other localities which I have described previously.[18] All that was missing was a fossilized skeleton of one of those mammoth hunters who had left meager traces of their manual skill around the valley. The question was in what manner such detection could be accomplished.

From a geologic angle, the lake flat was the ideal terrain for a search inasmuch as most of the mammoth remains had been found there. Construction ditches provided sufficient insight into the stratigraphic composition of the lake flat, particularly in that section which lay close to the older shorelines. If prehistoric man had been in this vicinity, he must have proceeded from those shores toward the swamp as close to his prey as his courage and the condition of the ground would have permitted. But how far such an adventure might have carried a hunter was impossible to tell. The lake flat containing mammoth remains stretched over a distance of 3 km westward and was 800 m wide. Still the terrain adjacent to the hospital grounds offered the best chances not only because of the existing exposures of the critical layers but for the accessibility as well. Even such selection still left 1,360,000 square meters for a search. This dilemma, in my judgment, called for application of a special method of detection.

The idea of applying a geophysical method for the location of either mammoth or fossil human remains came to me during a conversation with Dr. Paul Fejos, Director of Research of the Viking Fund, Inc., of New York. Dr. Fejos had for some time endeavored to interest archeologists in the application of geophysical devices and he told me of Dr. Hans Lundberg's experiments in this

[18] H. de Terra, *New Evidence, etc.* (1946).

particular field. Upon his suggestion I got in touch with Dr. Lundberg and discussed with him the proposition of conducting an experiment at Tepexpan. A special grant from the Viking Fund enabled us to carry out this project which I shall now briefly describe.

GEOPHYSICAL EXPERIMENT AND CAUSES FOR THE DETECTION OF FOSSIL MAN

The equipment used in this work consisted of the following apparatus: 1,200 meters of seven-stranded naked wire, 300 meters of rubber-coated seven-stranded wire, 2 6-volt storage batteries, 1 transformer (Lundberg), 1 audio amplifier (Lundberg), 1 pair of earphones, 2 metal searching rods, 150 metal stakes, 300 wooden stakes.

For the plotting of equipotential lines we used telescopic alidade, plane table and stadia rods. The method chosen for this particular study is known as the linear electrode method. It consists in sending an alternating current of low frequency into two conductor cables which are staked to the ground at a specified distance parallel to each other. In the electrical field thus established, lines of equal potentiality are traced by means of metal searching rods through which the current enters the amplifier causing a buzzing sound in the earphones. The "no sound effect" locates the points of equipotentiality which are marked on the ground by wooden stakes that eventually form distinct lines which are plotted on the map (Pl. 1). Homogeneity of the ground will cause these lines to run parallel to the electrodes, whereas lesser or greater conductivity of certain earth substances will result in deflections with convergent lines at places of greater electrical resistance and divergent patterns marking localities of greater conductivity.

Fig. 6 gives the map of the line pattern encountered on the Tepexpan site. With good practice, such a survey can be done within a few days. In our case it took a little longer because of certain delaying factors such as training of assistants and demonstrations for the benefit of some of our Mexican colleagues. Fig. 2 shows the position of the electrodes which were connected by rubber coated wire with the generator. In order to facilitate ground conductivity, the southern electrode was staked in the ditch below the caliche while the other was staked, 250 m north of the ditch, into the surface across the fields parallel to it.

The original plan had been to survey a terrain of about one square kilometer. However, when a notable deflection of the equipotential lines appeared in the southwest corner of the field, Dr. Lundberg judged that these strongly localized anomalies warranted excavations so that their precise cause might be fully understood. He designated the three places for excavation which are marked on Fig. 6 and later added a fourth one lying some 44 m east of the third spot. Fig. 6 illustrates that the excavations were made at points of maximum anomalies, and this precisely proved to be of positive value for the elimination of that much

larger area which had made the prospects for our search so extremely hazardous. In comparison with other factors this alone stands out as the major lead and conclusive proof for the value of the method employed. For what must now be revealed as geologic and soil conditions causing the electrical anomalies does not detract from the fact that localization was achieved geophysically. As for the causes of the electric anomalies one can distinguish between a general and a specific pattern, the latter being apparent around the fossil man site. As for the general pattern, greater conductivity was indicated by a wide divergence of the equipotential lines in the eastern field close to the village. The dominant factor here is to be looked for in the slopeward movement of such groundwater as flows from the basalt bluffs below a broken or loosened caliche through El Risco sand

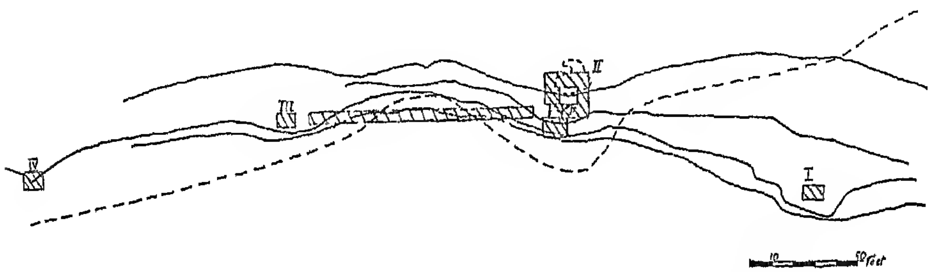

FIG. 6. GROUNDPLAN OF EXCAVATIONS AT FOSSIL MAN SITE, TEPEXPAN
Solid lines, equipotential lines of survey; stippled line, basinward limit of caliche. Numbers refer to excavation pits.

and clay. Under such groundwater conditions, the varying pore capacity of the caliche and its relatively shallow depth permit of greater concentration of electrolytes near the surface in contrast to the eastern field where the more stationary subsoil moisture is sealed off by caliche at relatively greater depth. For this reason the lines begin to converge where contours 2,241-2,243 display a uniform bend making a shallow embayment of the lake flat. Dry season conditions presumably brought out this pattern in exaggerated form since a rise of groundwater during the rainy season would have made for greater conductivity in the western field. The caliche margin follows the bend of the contours suggesting a leaching process induced by fluctuating surface and groundwater on lower ground whose contours still suggest a lagoon. Hence the sinuous margin of the caliche roughly follows the old shape of the lagoon, a fact singularly significant for the position of the fossil man. For, inasmuch as the human fossil lay at the caliche margin and at the edge of the El Risco swamp, it is obvious that its position was the most likely place where a hunter would have been mired: the edge of the deep swamp. The margins of both caliche and underlying El Risco muck almost coincide, the muck presumably bearing the strongest solvents for the fossil caliche soil.

From these observations it is easy to understand the specific pattern of electrical anomalies at the site (Fig. 6). Proceeding westward, the first strong convergence of lines coincides with a basinward projection of the caliche and conversely conductivity increases with the northwestward retreat of the caliche margin. General increase in resistivity being due to deeper position of the groundwater level in the more central parts of the old lagoon where moisture supply comes in from the basinward side rather than from the slope. The local deflections between excavation pits II and IV (Fig. 6) illustrate the control of the caliche margin upon conductivity.

Taken together, it may be claimed that the geophysical survey helped to eliminate all of the available ground except a portion along the former margin of the swamp where pronounced anomalies indicated the place most likely to have yielded human remains. In this sense exact location of the fossil was incidental only to the attempt of discovering the causes for the varying conductivity. In any event without the geophysical survey the Tepexpan Man would not have been discovered.

ACCOUNT OF THE DISCOVERY

While excavations were under way, I was personally satisfied with the prospect of locating additional mammoth remains, simply because of the expected association with artifacts. I had been working in this line of research long enough to know that fossil human remains had more often been discovered by accident than by deliberate search. I also felt that the one small wasteflake which Arrelano had found with one of the mammoths called for additional evidence of early human' remains.

Yet displeasure over this mistake soon enough turned into satisfaction when one of the workmen pointed to a dark roundish object which had been left untouched in the muck formation. Engineer Arellano of the Instituto Nacional de Geología, who had accompanied me that morning to assist in disbursement of the workers, witnessed my digging the human skull out of the clay where it must have seen the last light of day many thousands of years ago. It lay 48 inches below the surface and 14 inches beneath the caliche.

The skull was then left at the same spot for witnesses to study its original stratigraphic position. I returned quickly to the city to inform certain of my Mexican colleagues whom I knew would want to inspect the find. In the afternoon the following persons came to the site. Ing. Ricardo Monges Lopez, Director of the Instituto Nacional de Geología; Ing. Teodoro Flores, and Professor Contreras of the same institute, Pablo Martinez del Rio, Director of the Escuela Nacional de Antropologia e Historia; Ignacio Marquina, Director of the Instituto de Antropologia e Historia, and Señor Eduardo Noguera, Director of the Departmento de Monumentos Prehispanicos; Dr. Javier Romero, professor of Physical

Anthropology at the Universidad Nacional Autónoma de Mexico; R. Garcia Granados, and several representatives of Mexican, American and foreign press, and photographers who had learned of the discovery.

The skull was taken on that same afternoon in custody by the Museo Nacional through Dr. Romero. The following morning Dr. Romero, Ing. Arellano, and myself removed the remainder of the skeleton From the beginning we suspected that some fragments of the skeleton, especially the feet and portions of the back had been removed by the workmen while digging against my authorization. As it was difficult to sift the removed earth in wet condition, Dr. Romero waited until it had become dry. A month later, this sifting yielded some additional part of the feet, the sacrum and many small fragments of facial bones, etc. Hence, we are reasonably certain that no parts of the fossil were left in the ground.

STRATIGRAPHIC POSITION AND PRESERVATION OF THE FOSSIL MAN

The discussion of the stratigraphic position of the find not only involves the general geologic history of the region but the formation of those particular deposits which underlie the lake flats. The former having already been discussed, there remains the more detailed account of the deposits with which the fossil remains were found associated.

To appreciate the stratigraphic position of the find, it must be remembered that the composition of the lake flat was well exposed in the long ditch which is 1,620 m long in an east-west direction and 360 m long in a NNE-SSW direction with an average depth of 50 inches. It passes the fossil man site within 25 m and the two mammoth excavation sites, lying 320 and 620 m distant from it, afford exposures larger and deeper than the ditch itself. In view of this situation the geologic sequence encountered at the site was correlated with that found at the two mammoth localities (Fig. 7) and the stratigraphic equations derived therefrom related to the general structure as exposed in a major portion of the ditch (Fig. 4).

At the fossil man site (Fig. 7, B; Pl. 3, A) the most recent soil formation is composed of two distinct sandy layers, each of which represents soils with vegetation zones of their own. The upper soil (1) has living grassroots reaching down to a depth of five to seven inches. No swamp plants grow anywhere near the locality, not even in local mudholes or in ponds which form temporarily during the rainy summer season some 200 m south of here. The fine sandy nature and uniform light gray color of the upper soil betrays an immature soil type whose structure and composition is seasonally influenced both by wind deflation and deposition. Twisters are daily occurrences during the dry season causing constant shifting of the upper soil components. The underlying soil (2) is of dark-gray color with columnar structure and a notable concentration of humus substance at the base. Its thickness varies from three to six inches. Grass stems

may be seen in the upper layer proving that this was a separate soil whose darker color already suggests slightly moister conditions than the upper soil ever experienced. The preceding phase of soil formation was one of drier climatic conditions as suggested by a thin crust of dark saline matter (Pl. 2, A) one-fourth to one half inch thick, and dark sandy humus. This layer of calcium carbonate and opaline silica presumably originated from drying up of the swampy lake flats whose deposits underlie the late recent soils disconformably. This erosion surface not only witnessed desiccation of the swamp but prolonged physical and chemical weathering.

In general one might say that these two soils are immature and of the

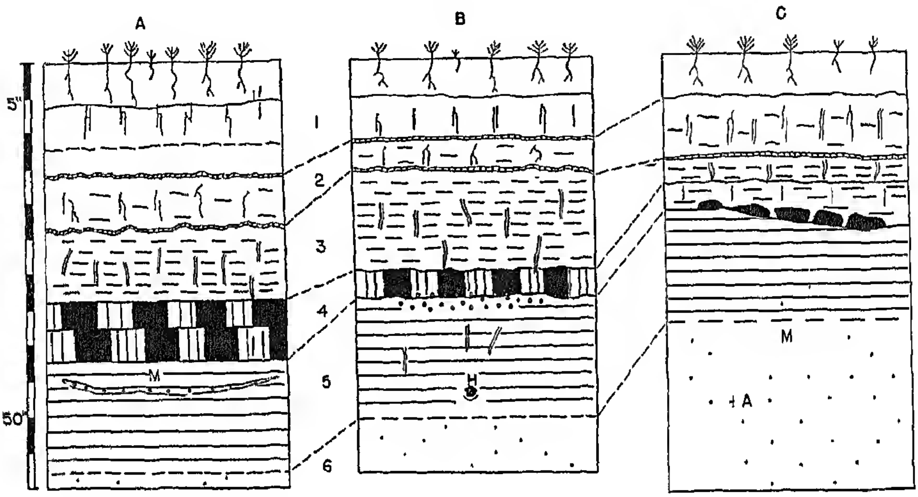

FIG. 7. CORRELATED SEQUENCES BETWEEN FOSSIL MAN SITE (B) AND MAMMOTH SITES A AND C IN LONG DITCH AT TEPEXPAN

Distances between A-B, 620 m; between B-C, 320 m. At base of layers 1 and 2 is a saline deposit. H, fossil human skeleton. A, obsidian flake. M, mammoths.

grassland type with at least one moister period indicated in the lower soil layer (2). The break with the preceding lacustrine phase is well marked by an erosion surface. This disconformity also separates the ceramic bearing upper strata from the sterile Totolzingo marl beneath (3). The sherds in the two soil zones belong to Early Teotihuacan and Aztec cultures, dating them back at least 1,600 years.

The second major division in the sequence (Fig. 7, B, 3, Pl. 2, A, B) is a gray silty marl with freshwater shells and root canals. This is the swamp or lake formation which produced the Zacatenco beach, representing a marked rise of lake level which succeeded the postglacial climatic optimum in the Valley of Mexico (Table 1). No greater contrast in climate and mode of origin can be

imagined than between it and the underlying caliche (4). The latter is four inches thick and mixed with pea-size fragments of pumice. The caliche obviously underwent alterations. Its sandy nature, the opaline silica components of its calcerous matrix, and the presence of root canals suggest weathering and leaching prior to the renewed flooding of the ground. Primarily deposited as a more or less solid sheet of alkaline concentrates derived from desiccation of a swamp as well as from surficial soil moisture, the caliche was exposed to weathering. This entailed not only physical break-up but chemical changes as well, notably leaching through sporadic rainwater and subsequently through rise of groundwater. This caused a loosening of the matrix permitting swamp vegetation of the next inundation to penetrate the caliche to a depth of one-half to one inch. Despite such changes, the break with the underlying buff and blackish clay is as well marked as in other places where the caliche preserved its solid structure as in section Fig. 7, A (Pl. 3, B). Moreover, there is no sign of an artificial disturbance, the altered caliche resting conformably on the lacustrine clay. Its presence above the layer containing the fossil man proves continuous deposition, a fact which becomes fully apparent from the section Fig. 4.

The buff to blackish colored clay beneath the caliche is the topmost member of the El Risco sand (5), a lake facies of the Upper Becerra formation. Its total thickness is 18 inches and at a depth of 14 inches below the caliche was found the human fossil. The clay is silty and even sandy in the lower portions and contains root canals as well as freshwater shells and diatoms.

The mineralization of the skeleton varies according to the embedding medium. The lower mandible, having lain in a lense of sand, is heavier and more mineralized than the other bones. When extracted the skull was coated with a film of black organic substance, soluble in acetone. The teeth show the same blackish stain. The brain cavity was filled with clay and since the man had falled face down, swamp plants had grown through the foramen magnum, with root canals preserved in the clay filling. Such uninterrupted growth of the swamp vegetation from the top of the clay layer into the bone cavities fully supports the picture of continuous sedimentation. This remarkable feature, together with the absence of any artificial breaks in the sequence, argues strongly for accidental burial and makes the assumption of interrment a most unlikely one, even if the flexed position resembles that of Archaic burials. That considerable parts of the skeleton are missing, such as the hip and shoulder bones, most of the vertebrate column and feet, may be due to the scavenging action of animals which attacked the exposed portion of the body. Since the ground was swampy most of the time, birds of prey may have performed this gruesome task.

In this connection the position and preservation of the other fossil remains found in this neighborhood (Pl. 8) deserves special consideration. Of the two elephants, one was found twelve inches below the caliche in sandy clay (Fig. 7, C)

and the other just below the caliche (Fig. 7, A) also in the same clay. A small flake of obsidian was encountered by Arellano at site C, (Fig. 7) at the same depth as the human fossil. Tusk fragments of elephants were found by me one inch below the caliche, 250 m north of this site. Another and rather perfect elephant skull was found in 1945 at the southeast corner of the hospital wall within an inch below the caliche. Such overwhelming evidence for the simultaneous burial of several elephants in the same geologic position as the fossil man strongly suggests that this prehistoric hunter was involved in the pursuit of one of these animals. Indeed the fragmentary preservation of the elephant skeletons themselves lends support to the assumption, as pointed out already by Arellano, that their bodies were carved up and scattered either by the hunters or scavenging beasts or both. In one instance, namely at the site excavated by Arellano near the eastern end of the ditch, the right foreleg was still in its original position. This indicates that the big beast was trapped in the soft ground from which it could not have extricated itself. The remainder of the skeleton lay scattered about in the clay with the large skull turned over.

With these prehistoric events in mind it is necessary to picture briefly the fossil content of that remote epoch.

FOSSIL CONTENT OF THE FORMATIONS

Diatoms. The lake beds assigned to the El Risco formation are particularly rich in diatoms especially in the sand and clays underlying the caliche near Tepexpan. Dr. Paul S. Conger of the Smithsonian Institution most kindly undertook a microscopic study of some samples which I collected at various localities in the Valley of Mexico. His identifications and accompanying remarks are of great help in reconstructing specific conditions under which these deposits were formed.

The El Risco sandy clay at Tepexpan contains the following diatom flora:

Key to relative abundance

VS—very scarce
S—scarce
F—frequent
C—common
A—abundant

Amphora veneta Kütz (S)
Campylodiscus clypeus Ehr. (F)
Cocconeis placentula Ehr. (S)
Cymbella gastroides Kütz (F)
Cymbella tumida (Breb.) V. H. (S)
Denticula thermalis Kütz (S) Epithemia Zebra (Ehr.) Kütz (F)
Eunotia major (W. Sm.) Rabenh. (S)
Comphonema parvulum Kütz (F)
Navicula ambigua Ehr. (S)
Navicula (Pinnularia) Dactylus (Ehr.) Kütz (S)

Navicula sphaerophora Kütz var. (S) Güntheri O. Müll. (F)
Navicula Vındis Nitzsch (S)
Rhopalodia gibberula, (Ehr.) Kütz (F)
Rhopalodia gibberula, (Ehr.) O-Müller (S)
Suriıella ovata Kutz (vars) (F)

In one of the samples from the elephant locality in the eastern part of the ditch, the diatoms were badly broken and corroded, sandy and conglomerate particles being present. Since this specimen was taken from right beneath the caliche, corrosion and breakage may have resulted from secondary changes introduced by exposure of the clay to surface weathering at the time of the caliche formatıon.

In the underlying El Risco sand preservation is much more perfect, suggestive of continuous quiet water deposition. The following species were identıfied:

Amphora veneta Kütz (S)
Campylodiscus clypeus Ehr. and varieties—commonest, most conspicuous and dominant form in this material, as well as in most all the samples.
Cymbella tumida (Breb.) V. H. (S)
Cocconeis Placentula Ehr. (S)
Denticula thermalis Kütz (S)
Navicula sphaerophora Kütz (Quite variable) (C)
Navicula sphaerophora Kütz var. Güntheri O. Müll. (A)
Navicula viridis Nitzsch (S)
Nıtzschia sublinearis Hust. (S)
Rhopalodia gibberula (Ehr.) O. Müll. (S)
Rhopalodia gibba (Ehr.) O. Müll. (S)
Surirella ovata Kütz (F)
Surirella ovata Kütz var. Utahensis Grun. (F)

"This sample is not so different from the other Tepexpan samples, but is probably the best of all the materials in the diatoms being intact, and not so badly fragmented. Much lime is present."

Dr. Conger in commenting upon these and other samples points out that the lake must have been shallow and large, "fed by waters draining equally abundant limestone rocks and siliceous rock materials." The lime component I suggest is due to solving action of existing caliche soils along the slopes against which these lake waters played. The primary source for calcium salts must be looked for in the feldspar of the volcanic rocks surrounding the valley. Varying amounts of volcanic glass and ash particles are present ın these sediments which in Dr. Conger's opinion may well account for the heavy diatom growth, particularly of *Campylodiscus clypeus* Ehr. According to Dr. Conger compaction of diatoms by lime with attendant corrosion is suggestive of a hard water lake having high pH content. The relative poverty of species numbers supports such a contention though marginal conditions, as indicated by *Navicula ambigua* and *Rhopalodia*

gibberula, may also account for the presence of so few really abundant species.

Of great interest is the occurrence of similar diatoms in recent lake deposits containing sherds of the Archaic culture in the Valley of Mexico. One such sample from an exposure in the Canal del Lago de Chalco near S. Isidro contained:

Campylodiscus clypeus Ehr. (F)
Epithemia Argus (Ehr.) Kütz (S)
Navicula ambigua Ehr. (F)
Navicula sphaerophora Kütz vars. (C)
Navicula viridis Nitzsch (S)

From the same vicinity a sample of diatomaceous clay from the El Risco horizon showed the following species:

Campylodiscus clypeus Ehr. (F)
Cyclotella sp. (VS)
Cymbella gastroides Kütz (S)
Cymbella tumida (Breb.) V. H. (S)
Navicula sphaerophora Kütz (F)
Rhopalodia gibberula (Ehr.) O. Müll. (F)
Surirella ovata Kütz. var. Utahensis Grun. (F)

"This sample is more compacted than most, with the diatoms rather fragmentary, dark in color, some sponge spicules. Not rich in diatoms." That diatoms are not entirely restricted to true lacustrine deposits is suggested by a sample derived from an erosion remnant of Becerra eolian silt some 35 m above the valley floor near Tepeyac. It contained *Navicula ambigua* Ehr. and *Cymbella sp.* Probably this silt was blown from out of the lake flats during Becerra time. Dr. Conger on the other hand suggested that it was deposited in a marginal lake area with periodically wet conditions. Such may indeed have existed in early Becerra time when the lake basin or lake floor was in a higher structural position than it is now.

Another sample from the Becerra formation came from the westernmost edge of the basin at the Presa de Concepcion near Tlalnepantla.

Rhopalodia gibba (Ehr.) O. Müll
Epithemia Argus (Ehr.) Kütz
Navicula 3 sp.
Stauroneis Phoenicenteron (Nitzsch) Ehr., and Amphora sp.

There may have been others also, not shown except by more lengthy study.

Finally from lacustrine El Risco beds in the Canal del Desague near Zumpango came two samples with the following diatom flora:

Sample Zu 1.

Campylodiscus clypeus Ehr.—Badly fragmented; dominant and almost exclusive form in relative numbers.

Navicula sphaerophora Kütz. var. (S)
Surirella ovata Kütz (VS)

Sample Zu 2.
Amphora veneta Kütz (S)
Campylodiscus clypeus Ehr. (S)
Navicula sphaerophora Kütz (F)
Rhopalodia gibberula (Ehr.) O. Müll. (C)
Surirella ovata Kütz (S)

Dr. Conger commented: "This is a poor diatom sample, with predominance of fine silty material (not diatom fragments) with much fine conglomerate material, dark in color. No diatoms are very numerous."

Invertebrate Fossils. In the Totolzingo marl (layer 3) as well as in the El Risco sandy clay (layer 5) were found the shells of *Succinea (Succinea) undulata* SAY and of *Physa (Alampetis) osculans* HALDEMAN according to identifications by Dr. F. Haas of the Chicago Natural History Museum. Dr. Haas commented as follows: "Both species belong to the actual fauna of Mexico. While the *Succinea* is a terrestrial species, *Physa* is a freshwater form and cannot live outside of the water, while *Succinea* often lives and even prefers places close to creeks and ponds or lakes."

These shells are often broken but at some places I found entire clusters of the freshwater form just below the caliche formation. The landform *Succinea* is common in the two soil zones and was found also around the Tlatel site in the lower ceramic levels.

FOSSIL VERTEBRATE REMAINS

The only specimen found in local association with the fossil man is a leg-bone (tarsometatarsus) of a pied-billed grebe (*Podilymbus podiceps*), a diving bird common in fresh-water marshes and lakes throughout North America. Dr. Alexander Wetmore kindly identified it as such and points out that the bone is identical in detail and size with modern specimens. Its presence 15 feet distant from the human skeleton and in the same layer corroborates the evidence previously cited for the marshy origin of the El Risco clay and sand.

The presence of imperial elephant (*Mammuthus* or *Archidiscodon imperator* Leidy) at various localities in the immediate vicinity of the fossil man site leaves no doubt of its being contemporaneous. Other animals such as *Mylodon* have been found in a similar horizon by Müllerried[14] at a locality some 25 km south of Tepexpan near Tepeyac where the lake flat is also underlain by El Risco sand and clay. While identifications of the mammoth specimens rest for the moment

[14] F. K. G. Müllerried, *Sobre un gravidado gigantesco* (Instituto Biologico Mexicana, Anales 5, 223-236, 1934).

on photographic records (Pl. 8), Dr. Claude W. Hibbard as well as Dr. G. Gaylord Simpson suggested that it is the imperial elephant with which we are dealing. A different opinion however was expressed by Dr. Bertrand Schultz, Director of the Nebraska State Museum, who pointed out to me that the molars of the hospital specimen exhibit some thirteen enamel ridges which would point to *Parelephas columbi*. He also indicated that the imperial elephant in Nebraska is a Middle Pleistocene form. Hence a final identification must await detailed study. Specimens of both genera are found in the collections of the Instituto Nacional de Geología in Mexico City.

More significant for the reconstruction of ancient life around Tepexpan is the fact that the oldest of the El Risco beaches (1) has yielded a number of fossils. They were collected by myself and by peons from the pueblo of Totolzingo from the sand pits which are located between contours 2,263-2,265 m about half a mile distant from the village.

Dr. Paul O. McGrew of the University of Wyoming has kindly identified a small lot of specimens, *Equus* cf: *semiplicatus, Thomomys* sp. (pocket gopher), *Odocoilus* sp (deer). Of these the horse belongs to a type common in the Rock Creek beds of Texas which are of Pleistocene age.

Through this paleontologic perspective the habitat of Tepexpan Man reveals itself as one endowed with grazing animals requiring more luscious vegetation than there is today. Yet the geologic fact that he lived at a time of relatively low lake level definitely points to the waning stage of an Ice Age climate at which time pastures for large herds of grazing animals had begun to shrink. These pastures probably persisted longest around the larger lakes like ancestral lake Texcoco, with mammoth, bison and deer crowding during ever lengthening dry seasons around lagoons and marshes. Thus began an ever accentuated struggle for existence which for Tepexpan Man and his kin must have presented ideal conditions for stalking their game. In this manner Early Man of the waning Ice Age in North America must have contributed to the extinction of many of the large land mammals.

UPPER PLEISTOCENE VERTEBRATE FAUNA IN THE VALLEY OF MEXICO

Fossil vertebrate remains are mentioned in Aztec chronicles which refer to them as bones of giants. Their presence has been reported by many scholars, notably by Alexander von Humboldt,[15] Owen,[16] Cope and Leidy,[17] Barcena,[18]

[15] Alexander von Humboldt, *Ensayo politico de la Nueva España* (1945).

[16] J. Owen, *On Remains of a Large Extinct Lama from Quaternary Deposits in the Valley of Mexico* (Philosophical Transactions, vol. 3, 1870), p. 65.

[17] E. D. Cope, *The Extinct Mammalia of the Valley of Mexico* (1884).

[18] M. Barcena and Antonio C. del Castillo, *El hombre del Peñon* (1885).

Felix and Lenk,[19] Freudenberg[20] and Furlong,[21] to name only the most outstanding contributors. Most recently a faunal list was made by Dr. Chester R. Stock on the basis of a new collection from Tequixquiac by the Instituto Nacional de Geologia. Considering that previous identifications required thorough overhauling, a full discussion of the Upper Pleistocene fauna must be deferred until such time when more reliable identifications are at hand In the meantime, the more recent identifications can be considered for their stratigraphic merits.

As far as Freudenberg's studies are concerned, it would seem that some of his stratigraphic concepts cannot be upheld in the light of more recent studies. This goes especially for the Tequixquiac fauna which he regarded as Early Pleistocene. Furlong[22] recognized a certain relationship with the Upper Pleistocene Rancho la Brea fauna of California, a view which appears to be substantiated by Dr. Stock's recent identifications.

The Tequixquiac fauna was divided by Furlong into a fissure and alluvial fauna, the latter occurring in the younger Becerra alluvium. From the fissure deposits Furlong listed: *Equus sp.*, *Capromeryx mexicana* Furlong, *Platygonus alemanii*, *Microtus* cf. *Californicus*, *Aenocyon dirus*, *Canis* cf. *ocropus.*

From alluvial silts and sands of the same locality, he mentioned: *Equus sp.*, *Bison* cf. *latifrons*, *Camelops* cf. *hesernus* Leidy, *Elephas columbi*, *Glyptodon* sp. These sands are identical with what I call younger Becerra alluvium.

Dr. Stock identified a number of fossils from the fissure and alluvial deposits. The former known as "la cantera vieja de Tequixquiac" includes the following forms: *Camelops* sp., *Equus* cf. *conversidens*, *Archidiscodon* or *Parelephas*, antelope, rabbit, *Canis sp.*, *Breomeryx* sp. deer, lynx. From several localities which I presume to be in the younger Becerra formation, fragments of horse, camelops, bear, cat, antelope *Parelephas*, peccary, groundsloth, *Tanupolama* and *Bison antiquus* are mentioned. An imperial elephant from here is in the collection of the Geological Institute of Mexico City.

Considering that this fauna at Tequixquiac is associated with artifacts and that the Tepexpan Man is of late Becerra age, contemporaneousness of Early Man with the late Pleistocene fauna can no longer be questioned in Mexico. This conclusion illuminates afresh the importance which the archaeologic remains of Early Man hold for the oldest chapters of Mexican prehistory. The stratigraphic position of these earliest traces of human workmanship is more fully apparent from two other localities where the geologic sequences substantiate the stratigraphic concept gained from the Tepexpan region.

[19] J. Felix and H. Lenk, *Beiträge zur Geologie und Palaeontologie der Republik Mexico* (1889).

[20] W. Freudenberg, *Die Säugetiere des Pliozäns und Post-Pliozäns von Mexico* (1922).

[21] E. L. Furlong, *Notes on the Occurrence of Mammalian Remains, etc.* (1925).

[22] *Ibid.*

ARTIFACT SITES IN UPPER PLEISTOCENE ALLUVIUM

WHILE the foregoing description of the Tepexpan finds proves the existence of Early Man in late Upper Pleistocene times, there are two other localities which have yielded traces of human occupation of great antiquity. One is at San Francisco Mazapan, near the pyramids at Teotihuacan and in the same drainage area of the San Juan river where Tepexpan is located. The other is near Tequixquiac, a few kilometers north of the divide near Zumpango which separates the Valley of Mexico from the Tule river drainage. It was here that workers found in the year 1870 during excavations for the Gran Canal del Desague a carved bone which the eminent Mexican naturalist Barcena[23] described as human craftsmanship, the first to have come from a fossiliferous Pleistocene formation in North America. Curiously enough, the same locality produced seventy-six years later at the occasion of my second visit a bone point and a few stone artifacts. Tequixquiac has also become known as a collecting locality for Pleistocene vertebrate fossils as was already mentioned in the foregoing chapter. Next to Tepexpan it is second in importance for the study of Early Man in this region and it deserves an exploration more detailed than the following description can give.

THE TEQUIXQUIAC SITE

The village is located some 62 km northnorthwest of Mexico City and the site itself is about 800 m south of the Estacion del Tajo, a ruined terminal of the abandoned narrow gauge railway which accompanied the old tunnel of the Gran Canal where it pierces the low divide between Zumpango and Tequixquiac. The northern slope of this divide is trenched by several barrancas, notably so by the barranca de Acatlan, which has exposed a complex geologic section (Fig. 8). In it appear essentially the same stratigraphic units as at Tepexpan, except for the greater thickness and different facies of the Young Becerra formation. For an evaluation of the respective geologic age of the artifact bearing horizon, a brief description of this section is essential.

The upper portion of the barranca is cut into an old alluvial fill which rests on volcanic rock (Fig. 8). In the brown weathered volcanic tuff which adheres to the rocky flanks one recognizes the Tacubaya formation (2), its brown hard clay contrasting with the cream colored and yellowish silts and clays of the Old

[23] M. Barcena and A. C. del Castillo, *El Hombre de Peñon* (1941).

Becerra alluvium (3-4). As in the arroyo section near Totolzingo, the Tacubaya clay is coated by caliche which appears to dip below the Old Becerra fill, in the manner of a fossil soil sheet on the slope of a previous valley subsequently buried under the Becerra formation. The older Becerra is here much thicker than on the Tepexpan hillslopes beginning with bentonite and pink clays (4) and ending with yellow-grayish silts (3). A second caliche separates these from the younger Becerra alluvium (5) which rests disconformably on the older alluvium clearly marking an erosional break and an interval of stream trenching. The Young Becerra alluvium in which the artifacts and fossil bones were found is composed of gray cross-bedded sand with gravel layers and yellow to cream colored silts on

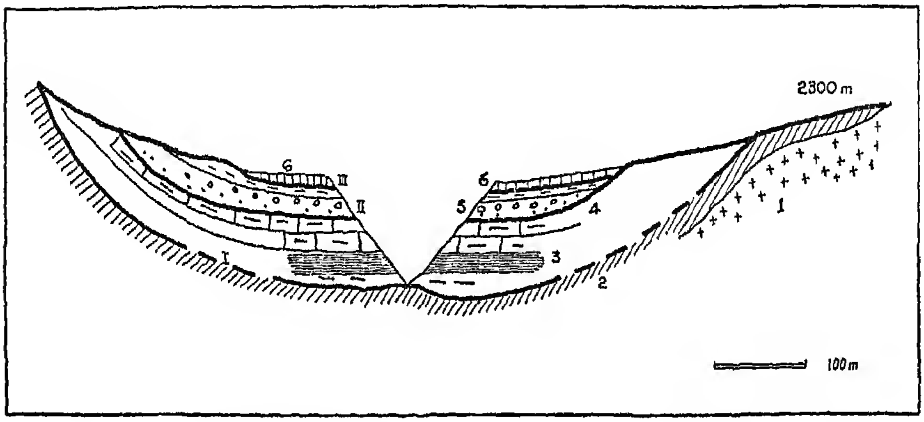

Fig. 8. Generalized Cross-Section through Upper Acatlán Barranca Near Tequixquiac

1, basalt. 2, brown Tacubaya clay. 3 and 4, Old Becerra alluvium. 5, Young Becerra sand and gravel. 6, Totolzingo dark silt and sand. I-III, interformational caliche.

top, the average thickness being 8-10 m. The "bone bed" of Tequixquiac appears some 2-3 m above the stream bed, usually at the base of bluffs with fossil bones appearing in relatively great abundance. Many of the genera previously mentioned came from this layer suggesting that this alluvial valley fill originated during a moist climatic phase during which grazing and browsing animals and freshwater turtles were rather abundant.

The artifacts found showed little water wear and came from the bone bed at a locality whose geologic composition is sketched in Fig. 9. Layers 3-5 represent the Young Becerra alluvium, lying disconformable on older Becerra deposits (1-2) which are clayey, suggesting deposition in quiet water, possibly a lagoon of an adjoining lake. By contrast the younger Becerra sand reflects a phase of stream aggradation with temporary torrential currents washing the hill sides and scattering the relics of Early Man and of vertebrate organisms. Significant is that the elevation

of this younger alluvium agrees with that of the older El Risco beaches near Tepexpan so that its formation may be correlated with a higher lake level which would account for the alluviation of the ancestral Acatlan barranca This relationship would make the artifacts somewhat older than the fossil man of Tepexpan whose remains presumably belong to a phase of falling lake level.

Now as for the discovery of the carved bone it is most unfortunate that the specimen was lost in recent years after the death of the Mexican archeologist

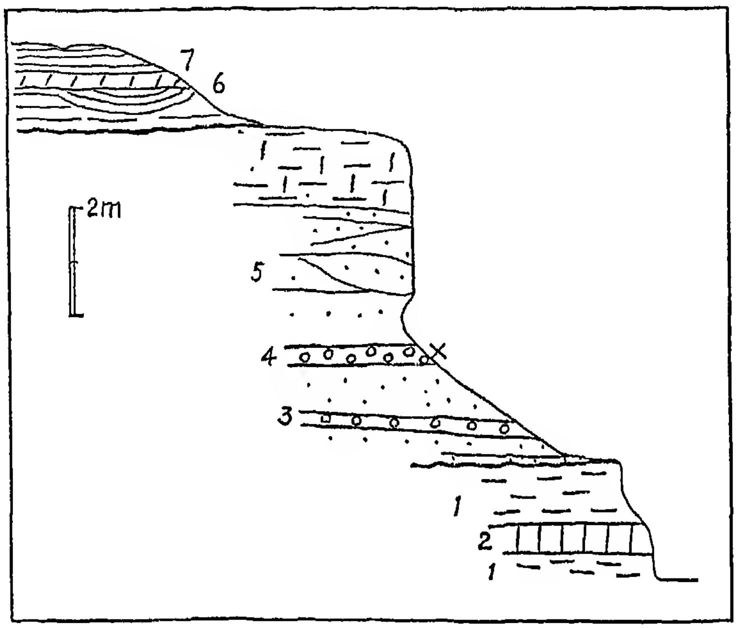

FIG. 9. WALL SECTION AT ARTIFACT LOCALITY NEAR TEQUIXQUIAC

1, gray clay with bentonite. 2, Old Becerra. 3, gray sand with gravel, Young Becerra. 4, bone bed with artifacts, Young Becerra. 5, pebbly sand and calichized silt, Young Becerra. 6, Totolzingo dark sand. 7, dark earth with potsherds.

Alfredo Chavero to whom it had been entrusted. However the specimen was described in great detail by Barcena whose scientific acumen was of such renown that most of his colleagues, including the great scholar Orosco y Berra, endorsed his conclusions as to the great geologic age. The report of the supervising engineer speaks of a depth of 12 m below the surface where the bone was found in what he called a tuff (toba) containing freshwater shells (*Anodonta planorbis*). Now this layer can only belong to the younger Becerra alluvium in which fragments of freshwater shells do occur. Barcena diagnosed the bone as that of a sacrum of an extinct llama, measuring 13.2 cm by 19.3 cm and impregnated in part by the matrix. It depicts the face of a coyote and was executed with considerable

skill by incorporating the natural shapes of the sacrum in the carving of the narrow and elongated face of the animal.

I feel justified in mentioning this old report not only in view of my recent finds of artifacts at a similar locality but more so on account of the extraordinary discovery of another bone sculpture near Tepexpan (see p. 84).

The analogy of the geologic sequence at Tequixquiac with that of the Tepexpan region becomes even more striking by the presence of dark gray tuffaceous earth (6) which marks a very distinct and final fill of the valley. In it one recognizes the Totolzingo formation, separated as near Tepexpan, by a caliche soil from the Becerra formation. If this site furnishes proof for both the geologic age of Man and the regional extension of the stratigraphy, the other site elucidates this picture even further.

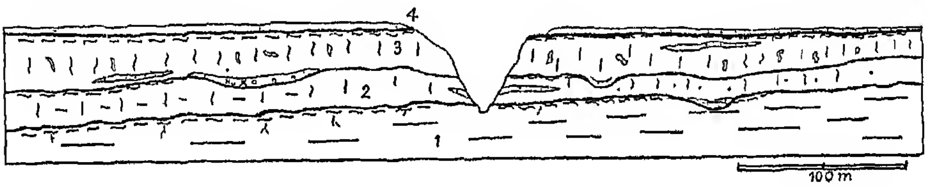

FIG. 10. GENERALIZED LONGITUDINAL SECTION NEAR S. FRANCISCO MAZAPAN

1, Tacubaya clay and brown sand with caliche on top 2, Old Becerra pink and light gray clay with sand lenses and locally caliche. 3, Young Becerra alluvium with basal gravel containing artifacts, caliche nodules and layers. 4, dark Totolzingo earth with intrusive potsherds.

THE SITE NEAR SAN FRANCISCO MAZAPAN

Where the great pyramids of the Sun and Moon rise from the floor of the San Juan valley near Teotihuacan, an ancient village is situated to the east at the edge of a deep barranca. The locality is some ten kilometers upstream from Tepexpan and within the identical drainage of the San Juan river which in past times has filled the wide valley with a variety of alluvial sediments. At San Francisco Mazapan the valley is several kilometers wide, flanked on either side by volcanic hills and volcanic breccia formations extending within a few hundred meters of the said barranca. Its walls expose a sequence of geologic formations which reveals once again the type of stratigraphy with which the reader has become acquainted through the previous descriptions.

The artifact bearing stratum was observed at the base of a cream colored silty clay where it contains irregular lenses of gravelly sand (Fig. 10, 3). This gravel is somewhat indurated and composed of obsidian and reddish basalt both of which rocks are components of the western valley flanks. Its stratigraphic and geologic positions are apparent from its sedimentary nature and structural relationship with other formations. The overlying silt (3) is some 14 feet thick, charged

with lime concretions and it still preserves the columnar structure typical for grassland soils developed on even valley tracts. This silt is calichized on top bearing in all the same characteristics as the top layers of the Young Becerra near Tequixquiac. Overlain by dark tuffaceous earth which hereabouts contains potsherds and other archeological relics, this gravel and silt occupy to all appearances the same position as the "bone bed" of Tequixquiac which is disconformable upon older Becerra clays. The latter are here represented by yellowish silt and sand, sometimes also of pinkish color, and with thin lenses of fine gravel. This layer in turn rests upon brownish firm clay and sandy clay, clearly stratified at places and with remnants of caliche clinging to its upper few feet. As in the Acatlan barranca this caliche appears along the disconformable contact with the Becerra formation. This basal stratum then is the Tacubaya substage of the other sections. It is this threefold division of the older alluvium which fixes the position of the artifact stratum as basal Young Becerra.

The artifacts found in the indurated gravel are worn by former stream transport and they were made of obsidian which here happens to be the most common rock in the neighborhood. Like those from Tequixquiac they are supposed to represent a culture to which I gave the name "San Juan."[24] Again their geologic medium carries, if in somewhat insignificant numbers, fossil vertebrate remains of which bones of elephant have been identified. It is probable that the Young Becerra alluvium of this valley corresponds to one of the higher lake levels inasmuch as its elevation is about the same as that of the older El Risco beaches. In fact, from observations made south of the Teotihuacan railway station it would seem that it grades basinward into a fine gray sand which is the lacustrine facies (El Risco) of the later Becerra formation.

The stratigraphic position held by the artifact bearing gravel here as well as near Tequixquiac is so nearly identical as to warrant the deduction that Early Man entered the Valley of Mexico at a time when most valleys were filling up under the impact of a pluvial climate with streams flowing vigorously between banks teeming with animal life. It would seem as if this rainier and cooler climatic phase provided for these early migrants an ideal habitat, more ideal for nomadic hunters than could ever have been presented by any succeeding geologic stage. Such a concept may henceforth guide future explorations in other regions. It is hoped that in the course of explorations more information will be gathered concerning these ancient geographic relationships.

While Tepexpan, Tequixquiac and San Francisco Mazapan have already provided data for a stratigraphic sequence it is nevertheless essential that at least a brief summary be presented which includes not only the glacial geology but the alluvial terrace formations as well.

[24] H. de Terra, *op. cit.*, 1946.

STRATIGRAPHIC AND CHRONOLOGIC KEY

FROM the outset of my field studies in the Tepexpan area it became obvious that a full understanding of this important district could be had only if the geologic data obtained there could be related to a larger stratigraphic pattern. In this manner only was it eventually possible to unravel the sequence of soil formations and geographic events with which the fossil man and artifact sites in the Valley of Mexico are related.

It was therefore necessary to examine in detail the geologic composition of large portions of the Valley of Mexico, not only the lake deposits but certain soil and alluvial tracts as well. In so doing two separate sets of stratigraphic data were obtained, one dealing with the ancient lake and the other with alluvial formations. While these records are by no means complete, they nevertheless already afford correlations between these sequences so that cross checking of chronologic data became possible. These alluvial and lake sequences were then correlated with the glacial sequence observed on the high volcanos Iztaccíhuatl and Popocatépetl (Table 1). Thus the geographic range of my explorations extended from the glaciated tracts down into the adjoining lake basin and valleys, resulting in a mass of information much too detailed to be included in this report whose aim is to disclose not only the presence of fossil man in Mexico but to provide a sort of geologic time table for the earliest cultures. This latter perspective makes it imperative that the most essential data be summarized with which a geologic dating was attempted. In so doing no full description can be given of certain localities where critical geologic sequences were obtained so that some of my conclusions must be accepted for their face value. Nevertheless a fuller presentation of my geologic field studies will be made at another time.

The theory presented hereunder deals precisely with the sequence of events as revealed by a geologic correlation between three separate sets of geologic data, the glacial, alluvial and lacustrine. This correlation is based on the fundamental premise that climatic changes within a given region made their respective impacts upon the movements of ice bodies, the behavior of streams and of lake levels. While it is true that a glacial advance will not promptly cause a lake to rise simultaneously or a stream to aggrade its course, it is nevertheless to be assumed that within a time span of, say, a few hundred years, the lake will rise due to the accumulated effect of the moisture climatic conditions which caused the ice advance. In this instance the three geologic sequences are sufficiently related in a geographic sense as to warrant the concept of close stratigraphic and chronologic ties (see Fig. 1, Table 1).

TABLE 1. STRATIGRAPHY, CULTURES AND CLIMATE IN THE VALLEY OF MEXICO

Geologic Age	Alluvial Sequence	Phases	Lake Sequence	Glacial Sequence on Iztaccihuatl	Climate	Culture Sequence
RECENT	Arroyo cutting and general erosion		Low lake level (artificial)	Ice recession to 4,600 m	Present	Modern
		I	Early Colonial lake	Recessional moraine I	Present	Classic Teotihuacan to Aztec
	Los Remedios terrace	II	High lake level—silts and tlatel deposits	Recession	Present with dry spell	?Early Teotihuacan 100–200 A D
	Erosion by 3–4 m	III	Lower lake level—saline crust II	Recessional moraines II and III	Moist spell	Late Archaic 300 B C.–100 A.D.
	Rio Hondo terrace	IV	High lake level—tlatel deposits	Ice recession	Dry spell	Early Archaic older than 300 B.C.
	Erosion	V	Low lake level—saline crust I			
	Totolzingo terrace and earth with caliche gravel at base	VI	High lake level (7–8 m above Early Colonial lake) Shell—and plant bearing lake marl, 8–14 inches	Terminal moraine of *Ayolotepito advance* at 4,350 m	slightly moister	CHALCO-CULTURE-COMPLEX
	Interformational caliche III 4 to 10 inches	VII	Caliche 0–8 inches—during prolonged low lake level	Prolonged ice recession of all then existing glaciers	drier than at present	beginning about 7,000–8,000 B.C.
UPPER PLEISTOCENE	*Young Becerra alluvium* terrace gravels and sands with vertebrate fossils, locally yellow powdery ash on yellow to cream-colored clays and silts with soil structures 12–30 feet	VIII	El Risco buff lake clay 8–20 in. El Risco beach III El Risco gray-greenish sand	Recessional moraines at 3,800–3,900 m (El Circo) *Trancas ice advance* moraines at 3,400 m trough valleys, outwash gravels with *boulders*, slightly weathered	waning of last pluvial cooler and moister	Tepexpan Man San Juan culture
		IX	El Risco beaches I and II			
	Interformational caliche II 1–2 inches Erosion			Interstadial deglaciation and erosion	drier and warmer	
	Old Becerra alluvium: loessial tuff, fine sands with gravel, clay and silts of gray to pinkish color, tuffaceous sand Vertebrate fossils in upper *clays 20 to 32 feet*		Bentonite Diatomaceous silts and clays	*Xopaná ice advance* moraines at 3,200–3,300 m brown soils, moraines much weathered, glaciers up to 5 km long	much cooler and moister	
	Interformational caliche I ½ to 1 inch Erosion *Tacubaya* brown hard clay and sand with limonitic concertions			Interstadial deglaciation and *erosion* *Salto ice advance?* boulder trains at 3,100 m and below	drier and warmer	

TABLE 2. SUGGESTED CORRELATIONS WITH OTHER LATE QUATERNARY SEQUENCES IN NORTH AMERICA

Phases as in Table I	Southern Rocky Mts.	Continental Glaciations	Great Basin, Arizona, W. Texas (after Antevs as of 1948*)	Eastern Texas
I II III IV V VI	ice retreating Sprague (Wisconsin V)		*Medithermal*, moder. warm and moist with dry spells ca 1300 A D. and locally in early Christ. times; rebirth of lakes and glaciers, Summer Lake max. 45 ft above modern level ca. 2,500 B C.	Warm and Dry beginning ca. 1,000 B C.
VII	Interstadial		*Altithermal*, distinctly warmer than at present, lakes and glaciers disappear, Summer basin dry ca. 5,000–6,000 B C.	
VIII	Long Draw (Wisconsin IV)	Cochrane ca. 8,000–9,000 B.C.	*Anathermal*, "Late Provo Pluvial," rather moist. Summer lake ca 90 ft. above present level, at first as today	Warm-moist beginning ca. 12,000 B C. Warm dry ca. 13,900 B.C.
IX	Corral Creek (Wisconsin III)	Mankato ca. 20,000 years ago	Provo Pluvial last glaciopluvial culmination, cool and moist	Cool-moist
Caliche II erosion in Mt. valleys	Interstadial			
Xopaná	Home (Wisconsin II)	Tazewell-Cary	Bonneville Pluvial cool-moist, highest lake levels	
Caliche I erosion in Mt. valleys	Interstadial			
? Salto	Twin Lakes (Wisconsin I)	Iowan		

* As provided by Dr. Ernst Antevs by personal correspondence. Dates for Eastern Texas based on the assumption that peat formation proceeded at about equal rate in the Patschke bog (40 miles East of Austin, Texas) described by J. E. Potzger and B. C. Tharp in "Pollen profile from a Texas bog," Ecology, 1947, pp. 274–280.

THE GLACIAL SEQUENCE

The sketch map (Fig. 11) may serve to illustrate the extent to which the western slope of Iztaccíhuatl provides data for the glacial sequence.[25] Two sets of older moraines can be distinguished which I have called Xopaná and Trancas after two critical localities situated on the higher slopes above the town of Amecameca (Fig. 1). For the older Trancas glaciation weathered moraines indicate an ice advance down to 3,200-3,300 m and for the succeeding Trancas glaciation down to 3,400 m. The present limit of the firn lobes which cover the saddle and flanks of this volcanic massif is at 4,600 m above sea level. Thus actual glaciers once filled the valleys to a length of six kilometers leaving at few places trough-shaped valleys and ice scored bedrock. A still older ice advance, called Salto, is suggested though not actually proven, by coarse boulder formations which in some valleys extend a few hundred meters below the limit of the Xopaná glaciers

Each of these glaciations is separated from the succeeding ones by substages of glacial retreat or interstadial phases with climatic conditions approaching those of the present. On the basis of the relationship between the respective moraines and the present ice limit it is to be assumed that these glaciations represent the major climatic pessima known as Wisconsin I to IV.[26] This deduction is of great importance for the entire concept of the geologic history of the Valley of Mexico inasmuch as it helps to explain why in this region the Upper Pleistocene formations were recorded by specific diagnostic soils and sediments which arrange themselves into a logical sequence of "pluvial" and "dry" substages.

Of equal significance are those glacial features which characterize the higher valley tracts close to the present ice border. These belong to the Recent geologic epoch and they consist of three sets of moraines indicated in Fig. 12, A Here we may distinguish between a large terminal moraine at 4,300 m resulting from what I have called the "Ayolotepito advance" and two younger sets of recessional moraines (M 1-2-3) deposited in the course of the general ice retreat during phases of slightly moister and cooler climate. And it is in this recent glacial sequence that we may find the data which render the later events of lake and stream sequences intelligible even to the point where actual dates can be set for distinctive phases as sketched in Fig. 11. The present ice has undergone recession within the last twenty years, a recession which is measurable at least for the last two decades. One valley in particular has furnished such clues, the Ayoloco valley, above Amecameca, where oriented photographs of the ice front had been taken

[25] This summary account does not permit a discussion of the data presented by previous observers, notably F. Jäger, *Forschungen über das diluviale Klima von Mexico* (1926); E. Ordoñez, *Las tobas calizas* (1890).

[26] A fourth glacial substage is suggested by certain recessional moraines at an elevation of 3,800-3,900 m as indicated on Table I (El Circo).

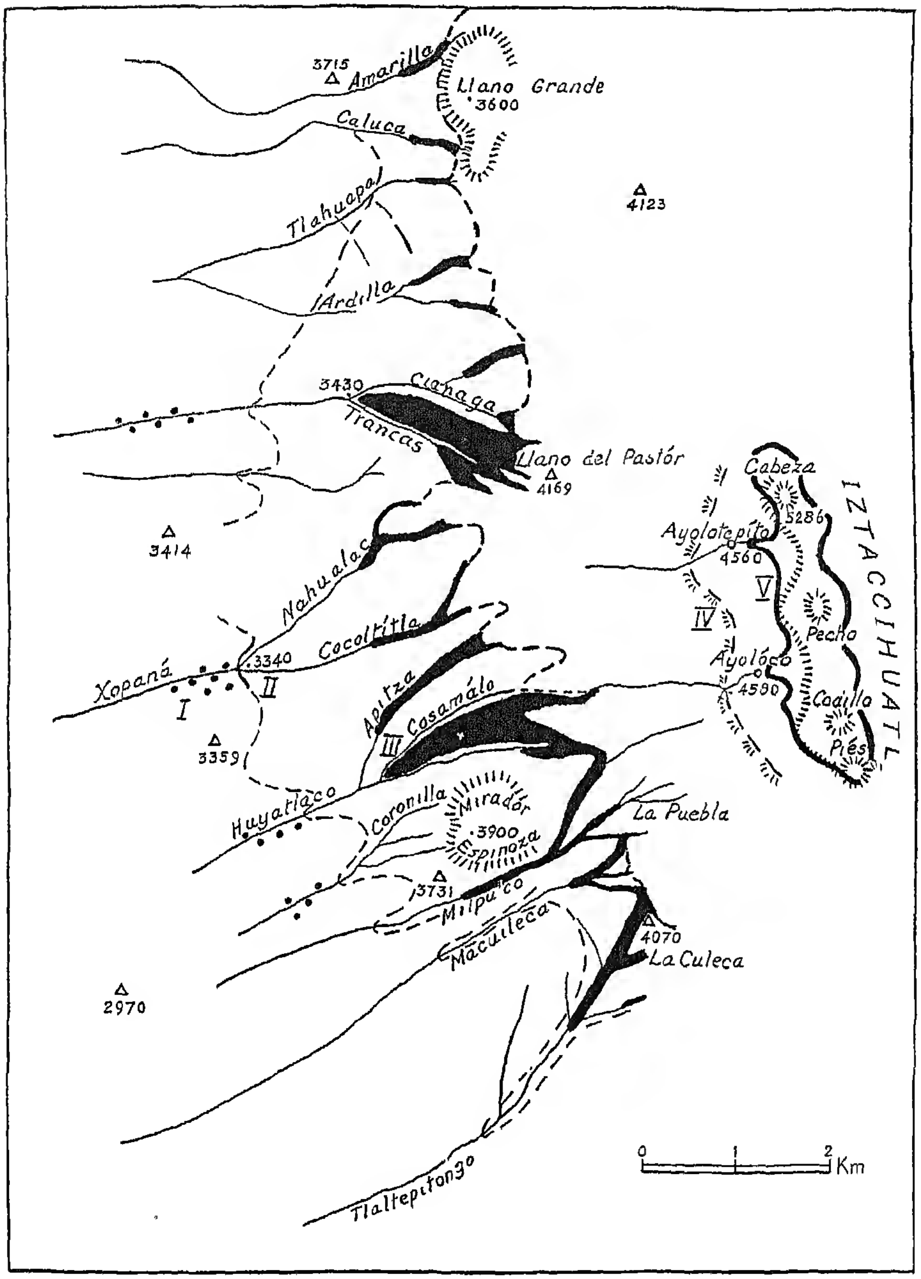

FIG. 11. GLACIAL FORMATIONS ON THE WESTERN SLOPE OF IZTACCIHUATL

I, boulder gravel of presumed Salto Glaciation. II, approximate limit of Xopaná Glaciation. III, valley Glaciers of Trancas Glaciation. IV, terminal moraine of post-Pleistocene advance. V, approximate limits of present glaciation. Elevations in meters above sea level; trigonometric stations marked by triangles, others by aneroid

twenty years ago by Mr. Hugo Brehme of Mexico City. These pictures when compared with the actual ice position of the Ayoloco lobe disclosed a retreat of at least 50 m. Now this figure cannot express anything but a net recession because the latest observations on glacier movements in North America and Europe indicate considerable oscillations during the last twenty years.[27] Nevertheless if in the absence of more reliable data for ice movements on Iztaccíhuatl one proceeds to calculate the very latest ice recessions (M 1-3) on the basis of observed retreat; one arrives at a chronology which surprisingly enough seems to be acceptable when a correlation is made between the last recessional phases and terrace stratigraphy (Fig. 12). Thus for the first recessional moraine M 1, I computed a date of 870 A.D. and for the others M 2 and M 3, 253 B.C. and 351 B.C. respectively.[27a] As for the age of the Ayolotepito advance, it is doubtful whether our observed figure of ice retreat can be applied considering that we are dealing with an ice advance for which no data are available. Yet in view of the recent aspect of this moraine AM it is permissible to regard it as belonging to the post-Pleistocene ice advance quite uniformly recorded in the Sierra Nevada of California and the southern Rocky Mountains.[28] Now in the former region this advance caused the rise of Owen Lake and presumably also that of Summer Lake in southern Oregon,[29] which agrees well with my correlation between the Ayolotepito advance and the rise of ancient Lake Texcoco (Zacatenco beach). On the basis of this analogy we might accept the dating given to Owen Lake by Gale[30] through the calculation of its salinity as about 4,000 years ago. A similar date is also suggested by Antevs for the beginning of the moist-cool phase which followed upon his "altithermal" (Table 2).

What do these figures mean in terms of the climatic history of the region? I should judge that rainfall was at least twenty percent higher than at present during this cool-moist phase resulting in greater water supply in the lake basin and neighboring stream valleys. This moist phase was preceded by a long dry phase because, according to my observations, the last Pleistocene ice had retreated almost to the crest of the mountain. And preceding this, the ice had advanced some 5 km down to a level of 3,400 m (Trancas advance). The latter glaciation can correspond only to Wisconsin III or IV in North America.

As for the recessional moraines they represent brief phases during which the

[27] F. E. Matthes, *Report on the Committee on Glaciers, 1941-42* (1942).

[27a] H. de Terra, *Teoría de una cronologia geologica para el Valle de Mexico* (Revista Mexicana de Estudios Antropologicos, 1947), wherein my calculations of ice movements have been described.

[28] Matthes, *op. cit.*, and Louis L. Ray, *Glacial Chronology of the Southern Rocky Mountains* (1940).

[29] I. S. Allison, *Pumice Beds at Summer Lake, Oregon* (1945).

[30] "Southeastern California Geological Survey Bulletin," 508-L, pp. 251-323 (1914).

general ice retreat was checked by slightly moister conditions which increased temporarily the supply of snow, thereby causing ice stagnations and decreasing simultaneously the rate of melting. Considering that moraines 2 and 3 lie close together, it is probable that both represent one climatic fluctuation or moist phase. Hence the glacial sequence might represent three moist phases of recent age, one preceding long dry phase and three shorter intermediate dry phases, or altogether seven climatic phases within the Recent geologic epoch To this must be added the great ice advance (Trancas) of late Pleistocene age and part of the succeeding retreat phase. This adds up to nine climatic phases. This glacial sequence may be correlated with the alluvial and lake sequences of the Lomas and Texcoco lake regions.

THE VALLEY SEQUENCE IN THE LOMAS REGION

On the Rio Hondo, on the western limits of the Federal District, in the vicinity of San Estaban, a detailed map was made under my direction by Ing. Marciono Moreno for the purpose of clarifying the alluvial sequence in its relationship to a number of archeologic sites. In this manner a geologic analysis was made in one of the more significant valley outlets which is illustrated in a generalized section of Fig. 12, c. In it one can distinguish between nine phases in the geologic history of the region beginning with the present (I) and ending with the Upper Pleistocene or Young Becerra terrace (IX). Terrace alluvium of the Recent epoch deposited by the ancestral stream is represented by phases II, IV and VI. Of these the oldest (VI) consists of fine gravel and sand containing caliche fragments but no ceramic remains The unconsolidated fine sand is of dark color and resembles in all respects the Totolzingo formation. It was largely buried under a younger terrace (IV) consisting of brown sandy clay and silt, two to three meters thick, with a light gray layer of volcanic ash and soil zones To this formation I gave the name "Rio Hondo" terrace and in it occur at San Luis Tlatilco numerous Archaic burials which have no equal in the Valley of Mexico for the perfection and variety of figurines, pottery styles and implements. A third terrace, named "Los Remedios," consists of brown sandy clay and contains rolled sherds of the Archaic culture period together with fresh ceramics of Teotihuacan and Aztec derivation. These three terrace units were preceded by two erosion phases (VII-VIII) and older alluvium of Young Becerra age. The latter contains indurated sands, cross-bedded with coarse gravel layers and it represents an alluvial fan, probably corresponding to a late Pluvial high lake level.

This alluvial sequence can be interpreted in climatologic terms as follows. In phase I streams entrench themselves due to lowering of base level of erosion, induced probably by the last historic and largely artificial lowering of Lake Texcoco. During phase II streams filled up their respective valley floors under climatic conditions not fundamentally different from the present. But the preceding

phase III witnessed slightly drier conditions with streams dissecting the Rio Hondo terrace because of lesser water supply and decreased transporting power. During the formation of the Rio Hondo terrace, on the other hand, climate was moister, slightly richer vegetation making for deposition of dark brown soils with seasonal inundations by the river. Preceding this another dry phase (V) caused dissection of

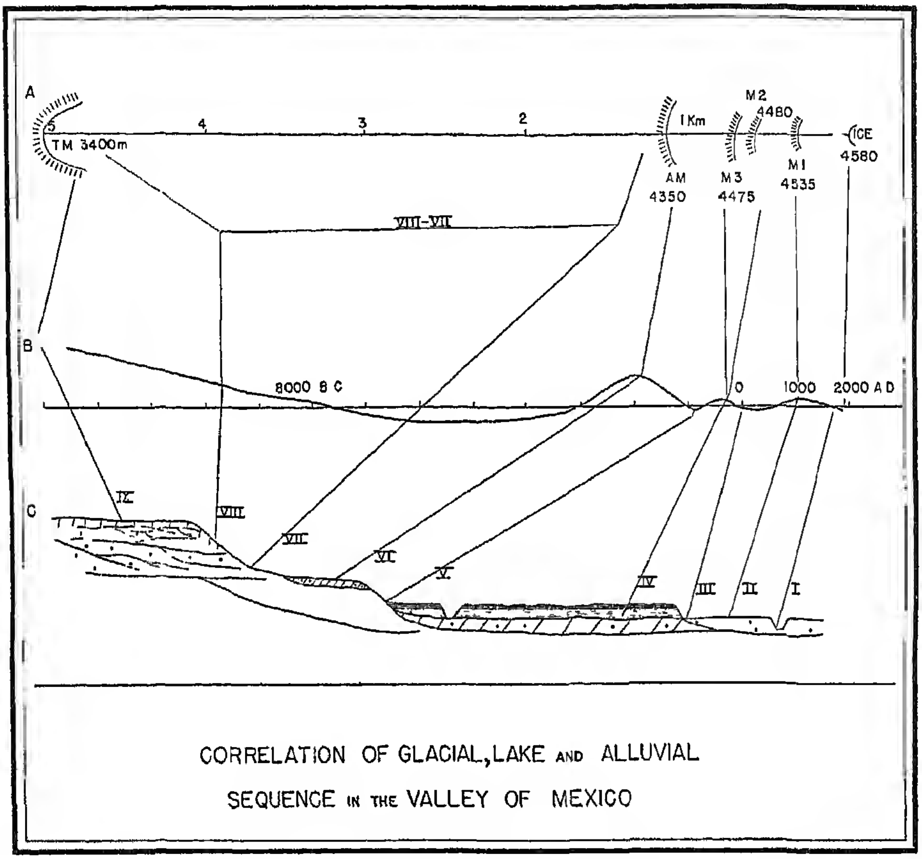

Fig. 12. Correlation of Glacial, Lake and Alluvial Sequence in the Valley of Mexico

the Totolzingo terrace (IV) by more than ten meters, the latter phase representing the moistest climatic conditions of the Recent epoch during which streams carried much water and eroded much of the fossil caliche soil on the valley slopes. This soil is now generally recognized in the region as an indicator of the dry climatic optimum following the end of the last Pluvial or Pleistocene glaciation. Its corresponding phase VII therefore is one of erosion. But the prominent slope existing between the Totolzingo and Becerral terraces (VI and IX) suggests that its

formation extended actually into the preceding phase of gradual desiccation documented in the glacial sequence by glacier retreat, and as pointed out below, by a falling lake level (El Risco beach 3). Hence the physiographic evidence for phases VII and VIII is presented by one slope only. The last and oldest phase IX represents the height of the last Pluvial of the Upper Pleistocene corresponding to the higher El Risco beaches I and II.

These climatic criteria of stream behavior and of soil formation correspond rather closely with those found in the glacial sequence and may therefore be considered more or less synchronous.

THE TEXCOCO LAKE SEQUENCE

The final test for this theory is presented by observations on the changing level of Lake Texcoco. As a rule, the best preserved of the ancient shorelines are those of the El Risco (Young Becerra age) and the Zacatenco beach. The former are seen near Totolzingo, Tepexpan and El Risco where gravels containing Upper Pleistocene vertebrate fossils, fish and insect remains and shells occur at contours 2,263–65 m, 2,257–58 m and 2,240–5 m. For geologic reasons explained previously, these beach lines cannot be used for accurate calculation of lake recession except the lowest El Risco III. In any event the picture is that of a receding lake level at the close of the last Pluvial (Younger Becerra and El Risco formations). The caliche making phase VII is documented everywhere even below the lake flats as at Tepexpan indicating maximum drying up of the lake. This was followed by rise of the lake and formation of Totolzingo marsh deposits and associated dark tuffaceous soils on the hill slopes. At this time the Zacatenco beach was made, easily recognized by shoregravel coated with lime (thinolite) at contours 2,247–48 m. The following lake fluctuation (V) is suggested by the fact that at Zacatenco and in the Chalco region the earliest of the Archaic habitation sites lie in diatomaceous silts indicating abandonment due to rise of the lake by a few meters. At Zacatenco signs of water deposition extend to contour 2,241 m only, or one meter above the assumed level of Aztec and Early Spanish occupation. The following fall of the lake would seem to be documented by the fact, noted by Noguerra and Apenes[81] that near Chimalhuacan, on the Texcoco side of the valley, a habitation site of early Teotihuacan culture I reached somewhat below the present Texcoco level. But this must have been a short dry phase for at other places later Teotihuacan and younger cultures occur quite uniformly in marginal partly water-laid refuse beds at 2,240–2,241 m. This level I assume to be the last of the historic levels preceding the artificially induced shrinkage of Texcoco lake.

Now this lake sequence when correlated with the alluvial sequence helps to

[81] E. Noguerra, *Excavaciones en el tepelcate, Chimalhuacan, Mexico* (1943); and O. Apenes, *The "Tlateles" of Lake Texcoco* (1943).

understand why phases of alluviation interchanged with those of erosion because, in times of higher lake level, streams were forced to deposit their sedimentary load in their respective valleys while in times of lower lake level their base level of erosion was lowered, thereby increasing the stream gradient and forcing the river to lower its bed.

I maintain that the correspondence between all three sequences is such as to warrant limited application of the time measures derived from glaciologic calculations. At the same time I realize that these time measures are not absolute but approximate inasmuch as climatic changes do not work like a clock even if they happen to have their corresponding impacts upon closely linked regions. Hence if I proceed to suggest dates for some of the ancient cultures so prominently represented in the Valley of Mexico, I do so with the full knowledge of the limitations which the geologic dating method implies.

DATING OF FOSSIL MAN AND OF PREHISTORIC CULTURES

AGE OF THE TEPEXPAN MAN

THE decisive factors in dating are to be found in the position of the human remains below the caliche and in the correspondence between this formation and a clearly marked dry climatic phase observed over a very extensive area in the western part of the United States as indicated on Table 2. The caliche is not a local deposit but was encountered in analogous sequences all over and beyond the Valley of Mexico so that its origin, as previously suggested, may best be explained by a dry climatic phase. Its superposition on the younger El Risco marsh deposits clearly indicates that this dry phase, or the caliche formation, immediately followed upon a lake phase during which man and mammoth were still closely associated. Now, the caliche (phase VII of Table I) can only be the long warm and dry interval which in the case of the Great Basin followed upon the late Pluvial. This dry interval, most recently termed "Altithermal" by Antevs, was dated by him as 5,000 to 6,000 B.C. or some 2,000 to 3,000 years later than the Cochrane ice border (Table 2). Considering the more southern latitude of our region some two thousand years may have to be added to Antevs' estimate since this dry phase most likely began earlier in the subtropical region. The beginning of the caliche phase may therefore lie between 7,000 and 8,000 B.C., an estimate which is corroborated by Zeuner's[31a] calculation of 8,000 to 9,000 B.C. for a maximum of summer radiation and a minimum of winter radiation.

Now the fact that the fossil man was buried beneath some sixteen inches of lake sediment of late El Risco age (phase VIII of Table 1) clearly indicates that he lived prior to the beginning of the caliche formation. Exactly how much time elapsed during deposition of sixteen inches of lake clay can be calculated, if only approximately, by comparing its thickness with that of the post-caliche marl (Totolzingo). At the fossil man site both have comparable thicknesses. Here the Totolzingo marl is overlain by a soil layer identifiable by ceramic remains of late Archaic culture type. Whereas the age of this culture probably dates back to about 200 to 300 B.C. with the moist phase IV having begun some 2,500 B.C. (Table 2), about 2,000 years may have been required for deposition of the Totolzingo marl. Such a time span would be necessary also for the formation of the Zacatenco beach. On this basis, the fossil man would antedate the beginning of

[31a] F. E. Zeuner, *The Pleistocene Period* (1945), 149.

the dry climatic phase by about two thousand years so that the age of Tepexpan man may be estimated at 9,000 or 10,000 B.C. or 11,000 to 12,000 years.

Yet this figure cannot be taken as an absolute date for the reason that the El Risco lake bed may well have been reduced in time by weathering and erosion prior to the caliche formation. On the other hand lake sedimentation in the Tepexpan lagoon may have been faster than during the Totolzingo substage in which case the age of the human fossil would be less than eleven thousand years. While it is possible that such a dating may eventually have to be revised in the light of new dating methods now in a state of experimentation, it is nevertheless certain that Tepexpan man lived at the very closing phase of the Ice Age, at a time when the lake had fallen to a level approaching the end of the El Risco formation. Precisely to what beach the mammoth and fossil man layer corresponds is difficult to decide because of the apparent absence of the El Risco beach III near Tepexpan. Also the fact that the valley floor underwent subsidence in more recent times makes a correlation with one of the El Risco beaches hazardous. However, it is certain that the mammoth layer cannot be as old as the El Risco beach I, considering that it lies twenty-five meters below it and some 1,200 m distant from these fossil localities. That is to say, the lake waters must have receded greatly from their position marked by the El Risco beach I in order to have created a lagoon sufficiently shallow for a herd of mammoths to have perished some few hundred meters off-shore. In fact it is very probable that the lake at that time had dropped already below the present contour of El Risco beach II or III.

As for the age of the Tepexpan industry, it is probable that it extends through a longer time span than the late El Risco lagoon formation represents. For one thing the alluvial bonebearing gravels of the Young Becerra formation contain a much richer land fauna than the El Risco lagoon, suggesting that Early Man first entered the country when big game was more plentiful. And this could have been due to richer vegetation and moister climatic conditions preceding the final lake recession. It is to be expected that future explorations will clarify this question with greater precision.

AGE OF THE CHALCO CULTURE COMPLEX

The few artifacts found in situ in the Valley of Mexico came from the Totolzingo marl and alluvial deposits. Others were found on the surface still bearing caliche patination. At Lake Patzcuaro a collection was made from the gravels of a high lake beach. These observations lead me to believe that the bearers of these fruit-gathering and small game hunting cultures occupied these regions both during the climatic optimum and in the much shorter moist-cool phase of some 4,000 years ago. Hence a considerable geologic time range must be assumed for the Chalco culture which upon further explorations may well turn out to comprise several cultures distinguishable by their specific tool types.

AGE OF ARCHAIC AND SUBSEQUENT CULTURES

The succeeding cultures are those of the Archaic. At the present state of my observations it would seem that the earliest, e.g., those of the Zacatenco I type fall at the end of the dry climatic phase V or the beginning of phase IV. Already Vaillant postulated a rise of the lake in the succeeding Zacatenco II stage though we can for reasons already mentioned not agree any longer with his concept of the Zacatenco beach. The prolifically rich site of San Luis Tlatilco on the Rio Hondo shows that the burials are contemporaneous with the late stage of the Rio Hondo terrace and according to my chronology this would correspond with the temporary halt of the ice as documented by the recessional moraines 3 and 2 which are dated 250 to 350 B.C. Since Tlatilco contains cultural elements of an advanced Archaic, Zacatenco I might well date back by 200 or 300 years prior to the climax of the moist phase IV.

The following short phase III of lower lake level should then fall within the beginning of the Christian era, a date which would correspond approximately to the very beginnings of the Teotihuacan culture. Since the Teotihuacan I level comprises ceramic elements of the Ticoman or late Archaic culture, such geologic dating would not conflict with the archeologic records. Noguerra's site at Chimalhuacan (south of Texcoco) with its occupation level below that of present Lake Texcoco would thus find a geologic explanation. And so would the low lake level postulated by Apenes[82] for this region which he correctly contrasted with a higher water level during the early Spanish occupation (phase II). That phase II is essentially that of the succeeding Teotihuacan and later cultures is not only evident from the refuse contained in the latest marginal lake silts but by low mounds containing Teotihuacan II and II pottery and figurines as represented by the Tlatél site near Tepexpan recently excavated by myself and Sr. Luis Aveleyra. Quite probably Spinden's[83] terrace site containing stream transported Archaic pottery near Atzcapotzalco is situated in my Los Remedios terrace of phase II.

This geologic chronology as far as it concerns the ceramic cultures does not conflict with the chronologic concepts which have more recently arisen from a critical appraisal of Vaillant's dating method. Vaillant,[84] it must be recalled, had proceeded to date his "Early Middle cultures" (Archaic) by comparing the accumulation rates of sherd refuse of his Mexican sites with those found in the Pecos region of western Texas. In so doing he was obliged to assign such a short time span (400 years) to the development of these early civilizations that archeologists found it difficult to conceive of such brief time spans in view of the ever increasing

[82] O. Apenes, *op. cit.*

[83] J. H. Spinden, *Ancient Civilizations of Mexico and Central America* (1934).

[84] George C. Vaillant, *Excavations at Zacatenco* (1930), and *Aztecs of Mexico* (1944).

number of Archaic sites and cultural differentiations presented by them. The Pedregal problem especially aggravated this situation inasmuch as, according to Vaillant's chronology, the Pedregal lava had buried the Copilco site which he regarded as contemporary with his (late Archaic) Ticoman level so that the lava itself could hardly be more then 1,500 years old. But such an age would hardly suffice to account for the erosion of this extensive lava field.

It is understandable therefore that Caso[35] proceeded on the basis of inferential data from the Mayan calendar, to extend the time concept for the Archaic cultures into the beginning of the first millennium B.C. And Kidder lately tends to accept such a longer time range because of the lengthy development of the monumental civilizations immediately succeeding upon the Archaic cultures. Now these concepts seem to be met by the geologic chronology resulting from my observations inasmuch as it places the lowest of the Archaic levels into the middle of the first millennium B.C. Hence the new archeologic time estimates agree better with my geologic chronology than previous dating methods had implied, which fact in itself affirms the value of the geologic procedure. Therefore if future archeologic explorations of early sites be carried out in application of such geologic methods, much will be gained in clarifying time concepts and conditions imposed by changing geographic environments. Only thus will it be possible to reveal at long last the mainsprings of American civilizations, in particular the origin of farming societies.

[35] Alfonso Caso, *El complejo arqueologico de Tula, etc.* (1941).

ARCHEOLOGICAL DATA ON PRE-CERAMIC CULTURES

TRACES of material culture remains belonging to a pre-ceramic age were found by me prior to the discovery of the Tepexpan man as reported in a previous publication.[36] In fact the first clues as to the existence of fossil cultures in Mexico were detected in the younger Becerra alluvium and in subsequent formations as well as in scattered surface sites in the Valley of Mexico. By comparison with the American Southwest these first traces are meager but they are significant in view of the previous total lack of information on really old pre-ceramic sites. Up to 1945 Mexican prehistory began with the Archaic or "Middle Cultures" of Vaillant, a term which previsaged the presence of still older cultures.

The French Scientific Mission[37] already had claimed an association of the large extinct land mammals of Mexico with prehistoric man but unfortunately not much attention has been paid by later students to these claims. Thus Mexico was a blank as far as information of this sort is concerned and by contrast the ever increasing number of pre-ceramic sites in the border states of California, Arizona and Texas soon presented a challenge to Mexican archeology. This challenge has finally been met in a manner which leaves no doubt any longer that the highlands of Mexico were occupied by peoples whose Stone Age nomadism contrasts so glaringly with the advanced civilizations of subsequent ages.

ARTIFACT SITES

Stone artifacts of very distinct types have been collected by me widely from the State of San Luis Potosi through Hidalgo, Mexico and Morelos to Oaxaca. They are present also in Michoacan, Guanajuato and Pueblo. So far only few sites can be definitely associated with datable geologic formations but this condition will undoubtedly improve as explorations proceed in a more systematic fashion. Stone industries hereunder called the "Chalco culture complex" are the most widespread and the most easily recognized in the field. Basalt rock was the preferred raw material though in San Luis Potosi rhyolite or silicified rhyolite tuff was used and in Oaxaca silicose limestone. By contrast the older artifacts from Upper Pleistocene formations were fashioned of chalcedony, bone or obsidian though their number is too small to judge which of these rocks was given prefer-

[36] H. de Terra, *op, cit.* (1946).

[37] E. T. Hamy, *L'Ancienneté de l'homme au Mexique* (1878).

ence over others. There is one industry however to which no definite geologic age can as yet as assigned and this is the "Tepexpan industry" which on typologic grounds and because of the exclusive use of white or grey silicose rock stands out as a very distinctive assortment of implements.

Sites in Becerra Alluvium and Late Pleistocene Beach Deposits. In the State of Mexico four localities are known: Tequixquiac, San Francisco Mazapan, Totolzingo-Tepexpan and El Risco.

In Post-Pleistocene Soils or Beach Gravels: Chalco, Tlatilco and Tezoyuca in the Valley of Mexico, Quiroga and Chupicuaro in Michoacan on the northern margin of Lake Patzcuaro, and Chupicuaro in Guanajuato.

Surface collections were made at numerous places of which the following are the more prolific localities: Tepexpan, Totolzingo, Cuanalan, Tezoyuca, El Arbolillo, Xalostoc, El Risco, Culhuacan, Chiconautla, Chimalhuacan, San Luis Tlatilco all of which lie in the Valley of Mexico.

In Morelos a rather prolific site was found by Dr. Henry Field on the outskirts of the city of Cuernavaca.

In San Luis Potosi scattered surface finds were made some four kilometers southwest of the state capital and in the Rio Verde basin.

Description of Sites. In the Valley of Mexico the more important sites are:

Tequixquiac, State of Mexico, by motorable road from Mexico City via Zumpango and along the new tunnel road, then on branch road into Acatlan barranca where 600 m south of old railway station (Tajo del Canal del Desague) younger Becerra gravels and sands with fossils are well exposed. From here were obtained specimens figured on Pl. 9, F, 10, B and others.[38]

San Francisco Mazapan. From the pyramids of Teotihuacan to pueblo and old stone bridge leading across barranca. Young Becerra alluvium with basal gravels exposed south of bridge, especially on eastern wall. Specimens figured on Pl. 9, A, B, E were collected here.

Totolzingo-Tepexpan. A variety of places mainly on hill slopes above contours 2,248 m with "Tepexpan industry" at levels between 2,258 and 2,265 m and Chalco culture artifacts.

El Risco. On the so-called Pachuca highway passing through Guadalupe to km 11. Across railway and at the foot of the hill a ditch which exposes El Risco III beach, caliche and sherd-bearing refuse. Patches of caliche cling to the volcanic rock some 30 m above where first Chalco implements were found.

Chalco. The locality is near San Isidro where the Puebla highway crosses the old drainage canal. Chalco artifacts were extracted from dark earth underlying ceramic bearing refuse beds.

Cuanalan-Tezoyuca. Opposite from Tepexpan on eastern flank of the valley, on lower hill slope between these two pueblos numerous Chalco artifacts.

[38] H. de Terra, *op. cit.* (1946).

San Luis Tlatilco, on the Rio Hondo near San Esteban, west of Mexico City, in brickyards as well as on hill slopes basalt artifacts.

Outside of the Valley of Mexico few sites have so far been explored and the better known localities are:

Chupicuaro, State of Guanajuato, on the banks of the Upper Lerma river whose ancient terrace gravels abound in Chalco type artifacts though on surface outcrops only.

Lake Patzcuaro, two kilometers west of Quiroga, on the highway to Chupicuaro, Mich., in ancient beach gravels which are crossed by the highway. Chalco artifacts of basalt.

Cuernavaca, Morelos, fields adjacent to the pyramid and scattered finds two kilometers each from here.

TYPOLOGIC ASPECTS

On the basis of present knowledge three distinct groups of stone artifacts are recognized which may briefly be described as follows:

Chalco culture complex percussion flaked, of basalt mainly, consisting of hammerstones, choppers, a great variety of scrapers, few handmill stones and points. Generally on hill slopes, in or above beach gravels (Zacatenco beach) and also in caliche soil or in older recent deposits below Archaic refuse beds. Wide regional distribution. The geologic time range from about 8,000 to 2,000 B.C.

Tepexpan industry: pressure flanked small implements of white chalcedony, mottled flint or quartz. Points, scrapers and gravers of folsomoid affinities, convex knives, hammerstones and high plano-convex scrapers. So far collected only from ancient beach near Tepexpan or along hill slopes near Zacatenco. Geologic age uncertain.

San Juan industry: very few authentic pressure flaked artifacts of bone, chalcedony and obsidian. Gravers and bone point, scraper and chipped pebbles. All from sandy alluvial gravels of the younger Becerra formation with fossil vertebrates (elephants, horse, deer, antelope, etc.) Geologic age probably from 12,000 to 20,000 years.

SAN JUAN ARTIFACTS

The ten artifacts belonging to this group were found in situ at three localities: S. Francisco Mazapan, Tequixquiac, and El Risco. Except for two specimens, all show dulled edges due to water wear. Five are of black obsidian with pearly gray translucency; one is of fossil mammal bone; four are of chalcedony, of milky and pink color. The choice of this material contrasts with that of the later Chalco culture which was fashioned mainly of basalt. Chalcedony occurs near Tequixquiac in silicified tufa of the cantera antigua (old quarry). The bone point (Fig. 13, A and Plate 9, F) was made from the bone of a large mammal, possibly bison. It was

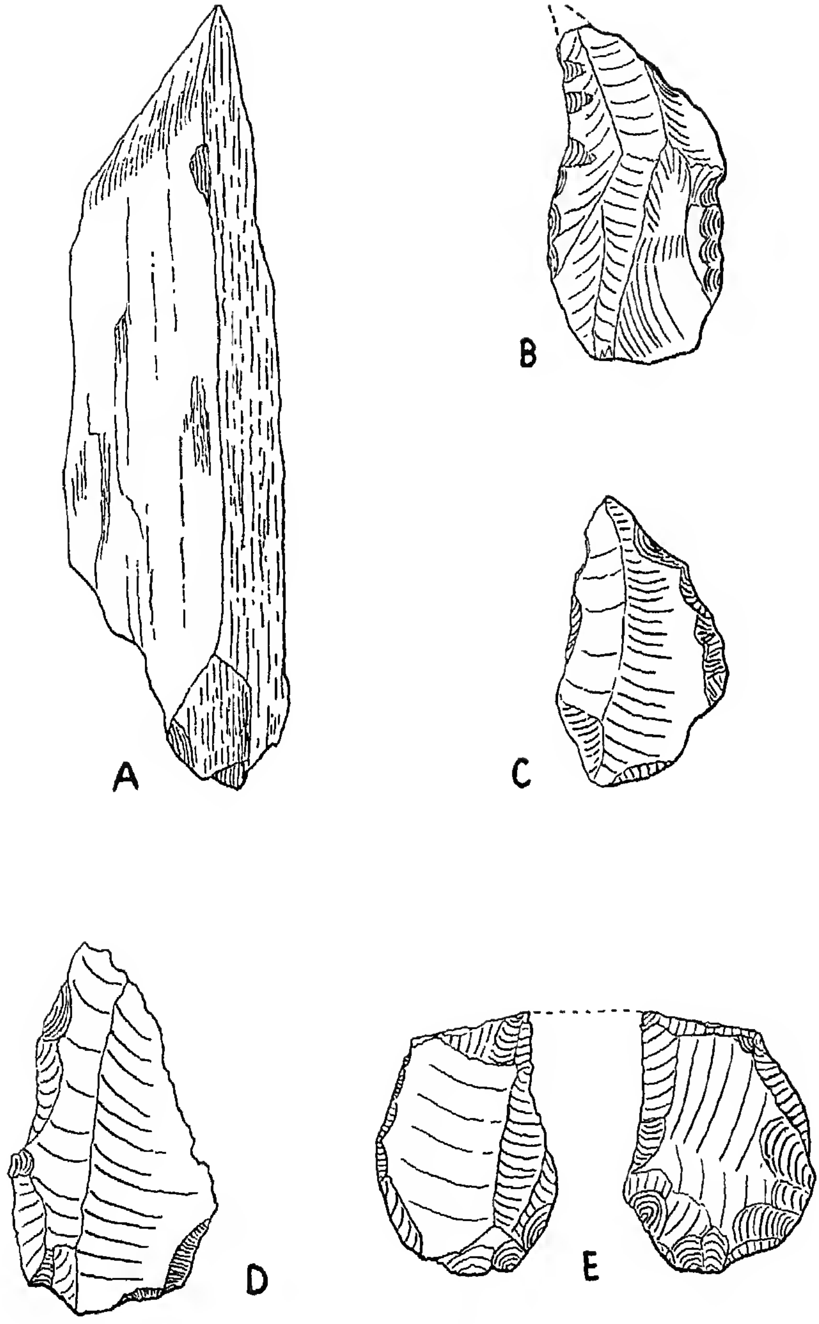

Fig. 13. Artifacts

A, bone point, loc. 3, Young Becerra alluvium. B, graver, chalcedony, loc. 3, Young Becerra alluvium. C, graver, obsidian, loc. 4A, Young Becerra alluvium. D, flake, obsidian, loc. 2B, El Risco beach III sand. E, graver and endscraper, obsidian, loc. 4A, Young Becerra.

split lengthwise with the outer edge slightly curved and sharpened to a point on one end. The sharpened edge is distinctly polished from use. Measurements: 10.9 cm long, 3 cm wide, 2.9 cm thick.

The two gravers, almost identical in shape, come from localities 4A and 3. From the former comes the obsidian specimen (Fig. 13, C and Pl. 9, B), a triangular flake with a convexly curved outer edge that tapers to a point. This convex margin is trimmed but the grooves are dulled through water transport. The point was probably broken off by the same action. The base shows a blunt point with traces of fine chipping on either side, such as might have resulted from drilling into hard objects Measurements: 4 cm long, 2.9 cm wide, 0.5 cm thick.

The chalcedony graver (Fig. 13, B and Pl. 10, B) still bears the bulbous flake surface on one side, its base is a reworked striking platform with the point

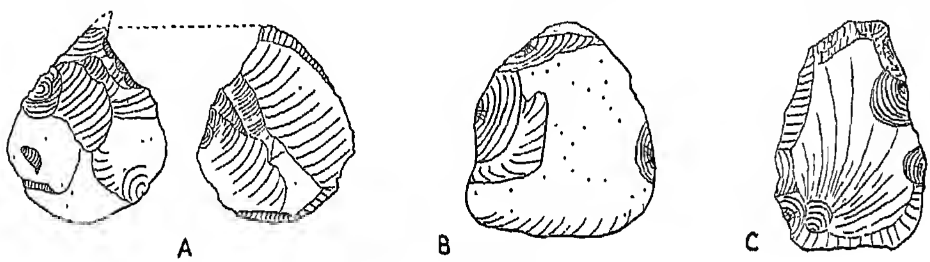

FIG. 14. ARTIFACTS

A, graver, obsidian, loc. 4A, Young Becerra alluvium B, chipped pebble, chalcedony, loc. 3, Young Becerra alluvium. C, sidescraper, obsidian, loc. 4A, Young Becerra alluvium.

of percussion preserved. The flake was struck from a prepared core. Two long flake grooves cover the convex side up to a ridge from which another pair of thin flakes were struck forward. The inner or concave edge was chipped so as to produce a sharp cutting edge. The tip of the point itself is broken off. Measurements: 4.6 cm long, 2.1 cm wide, 0.8 cm thick.

A third pointed tool (Figs. 14, 8 and 6, and Pl. 9, E) is an obsidian pebble, split in half and worked on either side. On the convex surface two flakes were struck from the base and the upper right edge sharpened by pressure flaking. On the reverse concave surface, flake grooves run obliquely from the upper edge so as to make a point. Measurements: 4.1 cm long, 3.8 cm wide, 2.7 cm thick.

The obsidian flake (Pl. 9, A) may be another graver, but the point is broken off. It may have been damaged in the flaking process because its semicircular base was used as a scraper as suggested by bi-lateral chipping. Measurements: 3.8 cm long, 2.7 cm wide, 1 cm thick.

The largest of the obsidian flakes (Figs. 14 and 9) obviously is unfinished. Its roughly triangular shape would suggest its having been meant for a point or a

graver. Instead it was used as a side scraper as shown by the pressure flaking on one side. Measurements: 5.8 cm long, 3.6 cm wide, 1.9 cm thick.

A small oblong plano-convex flake from San Francisco Mazapan shows dulled edges and may have been used as a scraper.

From Tequixquiac also came a small hammerstone of pink chalcedony (5.3 cm by 4.4 cm) and a chipped pebble of the same rock. (Figs. 14 and 8). From Loc. 2 B, (Figs. 13 and 5), came a rather fresh looking obsidian flake of triangular shape which was probably intended for a point. It shows minute chipping on the longest margin as if it had been used as a knife. The reverse side shows the original bulb of percussion and a small secondary flake scar at the pointed end. Measurements: 5.1 cm long, 2.9 cm wide, 1 cm thick.

As to the general typologic character of these artifacts, it is obvious that it suggests an advanced technique of pressure flaking and a diversified knowledge of tool types. The gravers, and the bone tool, end-scrapers, knives and points indicate their usage for preparation of skins. This is also suggested by their association with fossils amongst which elephant, bison and horse figure prominently. The most recent excavation of imperial elephant remains at Tepexpan in association with an obsidian flake corroborates this conclusion.

THE TEPEXPAN INDUSTRY

From the vicinity of the fossil man site at Tepexpan have come some fifty small artifacts of quartz and chalcedony which deserve to be classified separately. In doing so I am fully aware that this separation from the San Juan culture is artificial and will have to be qualified as soon as this industry is better known, both as to its stratigraphic and typologic position. The locality is on a gentle slope at the foot of the basalt cliffs, about half a kilometer northwest of the western limits of Tepexpan and about one kilometer NNW from the fossil man site. The elevation above sea level suggests the El Risco beach II (2,257-2,258 m) which extended along the bluffs from which a commanding view opens toward the lake flats. The surface concentration of these artifacts furthermore indicates that we are dealing with the workshop or camp site of people who obviously chose a locality nearby for its advantageous position on the lake shore. It is this location which suggests that the industry described hereunder may be contemporaneous with fossil man, for the lake with its seasonal fluctuations must have at that time rendered the lower ground wholly unsuitable for human occupancy.

Other artifacts of similar type have been collected from higher slopes near Zacatenco and some have even been found in the state of San Luis Potosi.

The specimens found within the valley of Mexico are of small size and were made of milky quartz or mottled light gray chalcedony or flint. Obsidian and basalt are entirely absent. A few bear caliche patination indicating that the camp site at a later time was covered by this type of soil. Typologically it is "Folsom-like"

inasmuch as the small gravers and scrapers would not be out of place in a typical Folsom site such as Lindenmeier in Colorado. There is one fragment of a point with the characteristic channel flake though other perfect points bear no traces of this feature so diagnostic for the Folsom tool complex.

Large Points. The three specimens at hand are fragmentary. The one bearing a channel groove on one side is 2.8 cm wide, the groove measuring 2.1 cm in width and the small marginal grooves from 3-4 mm (Pl. 10, E). A second (Pl. 10, E) is the fragment of a notched point of flint (3 6 cm wide) with a slightly concave base. It is patinated and dark gray on one side with specks of fine sand sticking to it. One reject of white quartz, 3.3 cm wide, has a thick elliptical cross section.

One dart point from a cave site in San Luis Potosi should be mentioned here although its archeological level is unknown. It was found near the entrance of a limestone cave which is situated on top of a prominent steep hill near San Pedro in the Rio Verde valley of that state. This point (Pl. 8, A), differs from all others by its broad shape and its shortness. It is of flinty dark gray limestone, 4 cm long, 2.8 cm broad at the base and 7 mm thick near the tip. It has a straight base, wedge shaped, and its side edges show small grooves 4 mm wide and 5 mm long. Similar points have been uncovered in the Folsom level of the Sandia cave in New Mexico. The San Pedro cave was not excavated because of the previous diggings made by treasure seekers who managed to destroy the original cave sequence.

Small Points. Of these eight are represented so far in the collection, four of which are notched, one stemmed, one apparently with straight margin and two are rejects. The large stemmed point (Pl. 11, E) was trimmed obliquely leaving a fine low ridge in the center with a few flake grooves extending all across. Actual length 5 cm, originally probably 5.7 cm, stem 1 cm long and 8 mm wide at base. The most perfect specimen (Pl. 10, H) is slightly notched and possesses a sharpened base with flake grooves extending at right angles to margins which are minutely trimmed. It is 3.5 cm long, 1.5 cm broad at base and 1.8 cm wide above notches. Another of chalcedony (Pl. 10, G) has a piece broken off above the base which is trimmed. Here the flake grooves extend to the middle without forming a distinct ridge. It is 3.4 cm long, 2 cm wide and 1.2 cm broad at the base. A slightly fractured specimen (Pl. 10, F) also shows a trimmed base, 2 cm wide, with grooves diagonal to the margins. Another one of translucent quartz (Pl. 10, I) has wide straight grooves meeting in the center in form of a fine ridge. The base of this specimen is broken off.

It is probable that the pressure flaking technique on all these specimens varied with the nature of the rock whose conchoidal fracture and hardness does not lend itself well to minute pressure flaking. This may account for the variety of the flaking plan displayed by these few specimens.

Gravers. Four specimens are represented of which one (Pl. 10, L) carries

specks of caliche patination on flake grooves This is 3 8 cm long, 2.8 cm wide and 9.8 cm thick with a point 5 mm long and trimmed on margins next to the point. Another specimen is thicker and of short rectagular outline with a triangular longitudinal section. The point itself is trimmed and was fashioned by pressing off three small flakes on one side and a larger one on the opposite side of the point. Most spectacular is a specimen (Pl. 10, A) which might be called a beaked graver. It shows a prominent flake groove in the center extending from the base almost to the tip of the point which is, however, incomplete. It duplicates the chalcedony graver of Tequixquiac (Pl. 10, B) described previously.

Knife. A small convex knife blade (Pl. 11, D) is 4.1 cm long, 1.8 cm wide and possesses a low keel on one side with flake grooves extending from tip to base along the convex or knife edge.

Scrapers. Five types can be distinguished: beaked, double endscraper, convex sidescraper, simple endscraper and plano-convex. The beaked form (Pl. 10, J; 18, D, 4)is low keeled with trimming on beak as well as on one edge. The double endscraper (Pl. 10, E) is rectangular, 2.7 cm long, 2 cm wide and 1.1 cm thick. Both ends are trimmed with individual grooves 3 mm wide. The convex sidescraper (Pl 11, G, H) (Pl. 18, B) is high keeled and trimmed on the convex edge only with pressure flaking having been applied from the center keel to the edges. The end scraper may have various shapes as illustrated on Pl. 11, B, C, E, 1; Pl. 10, C, M; Pl. 18, C, E depending on the shape of the flake from which they were worked. Trapezoidal and short rectangular shapes seem to dominate. The plano-convex type (Pl. 11, I) was made of small core pieces with high angle stepped flaking applied to the steepest edge and trimming on one or two sides. A few are up to 8 cm high and could be mistaken for cores but for the edgewise trimming

Hammerstones. These were carefully prepared from core pieces. The high keeled portion was shaped especially to accommodate thumb and middle fingers. A striking edge was made by knocking off a few large flakes from the flattest portion of the core.

CHALCO CULTURE COMPLEX

Specimens assigned to this group are by far the most numerous in the collection and with few exceptions all are of a dark dense variety of basalt. This is because collecting was done in areas where this type of volcanic rock abounds. On a brief visit to San Luis Potosi a few were collected made of rhyolite tuff of orange and reddish color. Near Mitla in Oaxaco a few were found of silicose limestone. Some specimens bear traces of caliche patination, others have dulled edges from weathering or surficial water transport, some show a characteristic grayish patina derived from decomposition of the feldspar matrix in the basalt The handmill stones are much weathered with a pocketed surface on specimens made of coarse grained andesite in which feldspar clusters and crystals are decomposed. The small lot

from the beach gravels at Lake Patzcuaro is ochre stained. Patination therefore is rather characteristic for the majority of these tools.

Points. Three types are represented by four specimens, a leaf-shaped long point, with straight base, a small convex point with maximum breadth in center and a small convex point broadest near the base. The leaf-shaped point is of dense dark olivine basalt with a thin gray patina (Pl. 12, A). It is 12.5 cm long. The tip is broken off, the base straight but constricted. Actual length 12 5 cm, original perhaps 14.5 cm, max. width 3 cm, medium thickness 1.5 cm. Small flake grooves measure 28 over a length of 12 cm with an average width of 3-4 mm. The grooves reach only one half or one third up the center ridge which itself is the product of pressure flaking applied from the sides as well as from the top. The cross section is elliptical and thickest about half way up from the base. The straight constricted base is repeated again in a small fragment from the caliche soil near El Risco (Pl. 9, C). The leaf point was found at Tezoyuca at a depth of 10.60 m in a sandy earth belonging to the Totolzingo formation. As the latter is exposed in the sand pits of Cuanalan, some 2,000 yards north, in stratigraphic position between Archaic refuse and fossiliferous El Risco sand, I hold this specimen as belonging to the Chalco culture complex.

A second projectile point (Pl. 12, B), possibly belonging to this culture comes from the vicinity of Tepexpan. It was made of dark slaty basalt, is 5 cm long with a maximal width of 2.4 cm, and only 1.2 cm wide at the base. Its thinness (0.7 cm) and small size suggests a hafted atl-atl point. As it was found on the surface of the lake flat it is impossible to tell whether it actually belongs to this culture or not.

A triangular point (Pl. 12, C) came from the ancient beach of Lake Patzcuaro, near Quiroga. It has a brown patina and its tip is missing. Length 4 cm (actual 5.5 cm), width 2 5 cm, base 1.5 cm. It was fashioned from a thin flake and shows little trimming on the sides.

Rejects of points of basalt are illustrated on Pls. 9, C, D, and G. The last may have been intended for a spear point, but it was left unfinished with the original flake surface on one side and relatively large lateral grooves indicating the first rough shaping through pressure flaking. The median groove may have been intended to flatten the point prior to the more minute trimming.

Scrapers. Two major classes may be recognized in this group which has furnished the majority of the tool complex, a low-backed and a high-backed or plano-convex group. The former is represented by various shapes rectangular, ovoid, discoidal, triangular and beaked. In the plano-convex group are found concave-triangular, pointed, tortoise backed types.

Discoidal (Pl. 9, H; Pl. 14, D, E) type measures 5 by 6 cm or slightly smaller or larger, usually with one flat side and the other percussion flaked and trimmed all around or on one side only (Pl. 14, E). Trimming was by steep angle blows

from the flat underside subsequent to low angle or horizontal chipping on the convex side. Pl. 14, D shows an interesting technique not infrequently employed in other types, which consisted in preparing a marginal depression on top for better accommodations of the thumb. (See the chopper scraper Pl. 14, C).

Rectangular (Pls. 17, A, B; 16, B) measures about 7 by 5 cm and is 2.3 cm thick. Double and one sided endscrapers are found with a marginal steep angle retouch executed from the flat original flake surface. Again horizontal flaking provided a better grip of the fingers illustrated on Pl. 14, B, which is a fractured endscraper bearing specks of caliche patination. A low keeled type is figured on Pl. 14, A in which instance the flake had been struck from a prepared core. In some instances the patinated original core surface can still be recognized.

Ovoid or egg-shaped forms (Pls. 14, F,·G; 14, A; 12, E) measure 8 by 4 or 9 x 5 cm. Some look like rejects (Pl. 14, G) but since they bear a slight trimming or shatter marks on the sharpened margins must be considered real implements. They are percussion flaked either from prepared or rough cores. The larger sort has one flat side from which trimming was done on one edge.

Triangular (Pl. 15, B and Fig. 15, D) measure 9 by 6 cm or even larger; they are generally quite flat on one side with steep angle flakes removed on all sides, the broader end having been trimmed for an endscraper. Most of these seem to have been made from a prepared core.

Beaked (Pl. 12 and Fig. 15, E) endscrapers measure 5 or 6 by 4 cm triangular in a longitudinal cross section, they show careful trimming on the steep side. All of them were made from flakes and for the best specimens a dense almost glassy variety of basalt was chosen.

Whereas the flat shape of these scrapers already suggests their derivation from flakes, the plano-convex types were in the majority of specimens made from cores.

Plano-Convex Scrapers. It is probable that most of them were fashioned from split pebbles or at least from rock fragments of roundish outlines and sufficiently thick to permit splitting them in a manner which left one fragment suitable for steep angle trimming. Important is that on some specimens the flat side is slightly polished from wear suggesting perhaps that some of the round shaped types were used for grinding in addition to scraping. Rarely is the flat surface straight, more often either slightly concave or convex depending on the original shape of the broken surface. Another characteristic is the fully convex shape quite clearly designed to provide a firm grip in the first or between thumb and middle fingers. This intentional shape is most clearly seen in the specimens illustrated on Pl. 16, E and Pl. 9, J.

Concave-Triangular (Pl. 12, F) measuring 7 by 6 cm or larger and 5 by 7 cm high with the concave margin trimmed or worn from use. The concave shape is in some specimens more accentuated than in the illustration of this type. The triangular shape was achieved by striking off two large flake scars from the base and

margin with smaller flakes struck from opposing sides. The underside is flat or nearly so.

Pointed (Pls. 16, E; 15, C) and (Fig. 15, D) e.g., the convex back is trimmed to a cone or forming a short keel. In the former instance flaking was done from the

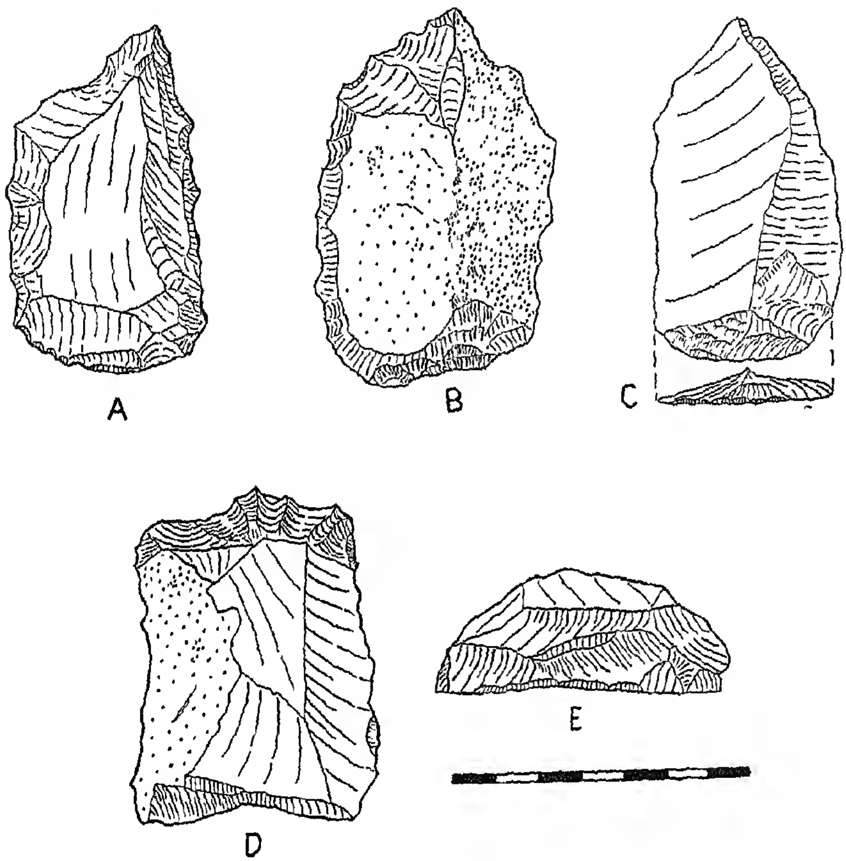

FIG. 15. ARTIFACTS

A, graver, basalt, loc. P, high beach gravel. B, pointed scraper, basalt, loc. P, high beach gravel. C, beaked endscraper, basalt, loc. P, high beach gravel. D, rectangular scraper, basalt, loc. P, high beach gravel. E, plano-convex scraper, basalt, loc. P, high beach gravel.

underside upward with secondary short flakes having been struck all around. This skillful handling of basalt is perhaps typical for this culture which produced spear points which reach a perfection of form otherwise matched only by the so-called Yuma points. Wherever the raw material was more suited as in the specimen illustrated on Pl. 15, E which is of silicified rhyolite tuff, the skill of this technique is clearly apparent.

Tortoise-Backed types (Pls. 9, J; 12, H) of various sizes are such as have their convex surfaces trimmed so steeply that they are as round or rectangular on top as at the base. Others again are excessively steep with irregular base and large flake scars slanting from a flat upper surface. Transitions exist between this type and the pointed forms.

Choppers (Pls. 12, G; 13, D; 14, C; 15, D) occur in various forms ranging from clumsy pebbles trimmed on one side only to discoidal types which bear shatter marks on two or all sides. A combination of chopper and scraper in one instance (Pl. 14, C) shows a concave flake scar on top to accommodate the thumb of the right hand.

Hammerstones are relatively few in the collection and these show large elongated pebbles battered on the side or on both ends.

Gravers (Fig. 15, C) resembling rectangular scrapers are few in numbers. In some the point is located centrally on one of the smaller ends, in others the point lies sideways giving the implement a beaked form.

Milling Stones (Pl. 17). There are not more than ten but significantly enough six of them came from terrace surfaces near Tepexpan where they were found in surface association with basalt scrapers. The lot consists of one large metate fragment, six manos, and three pestles. They are made of coarse basalt and andesite and display pitted faces from which grinding polish has vanished completely except on one mano. The pitted surface is the result of prolonged exposure to surface weathering which eliminated single feldspar crystals or clusters of feldspar matrix. Most of the specimens are asymmetrical with faces showing signs of abrasion rather than pecking. These characteristics distinguish them clearly from similar milling stones known to occur in Archaic and later ceramic levels.

The metate shows a nearly flat, slightly concave grinding surface with the bottom abraded on the edges, the whole having rectangular shape with rounded corners. Total length about 25 cm. Two circular mano fragments (Pl. 17, A, B) show bifacial abrasion, measuring 10 and 9 cm in diameter and 4.5 cm thick in the middle. A rectangular mano (Pl. 17, A, B) shows bifacial abrasion, measuring 10 and 9 cm in diameter and 4.5 cm thick in the middle. A rectangular mano (Pl. 17, C) displays rounded edges with a pecked undersurface.

The oblong manos (Pl. 17, C, F) show an ellipitical cross section, one of which preserves on one face grinding polish All are broken in the middle with relatively fresh surface on which no weathering is discernible.

RELATIONSHIPS WITH PRE-CERAMIC CULTURES IN THE UNITED STATES

On a chronologic and typologic basis the Mexican artifacts would seem to fall into two groups, an older culture associated with late Upper Pleistocene alluvium or corresponding lake beaches and with dominantly pressure flaked

implements, and a younger culture, or cultures, related to the Recent epoch represented regionally by percussion flaked tools. This distinction already reflects the conditions prevailing in the Southwest of the United States where the Sandia Cave, Folsolm and Yuma archeological levels represent the Paleo-Indian hunting cultures of the Late Glacial geologic epoch, while the "Chiricahua" and "San Pedro" stages of Cochise, the Pinto Basin, and Ventana Cave sites portray a more recent complex of small-game hunting and fruit gathering peoples.

While artifacts are too few from the Upper Pleistocene alluvium in the Valley of Mexico to permit any definite conclusions, it is nevertheless certain that they were made by a people whose hunting grounds abounded with big game such as mammoth, bison, horse and sloth. At the three localities known so far their bones are in direct stratigraphic association with artifacts of the San Juan culture. Between it and any of the known Late Glacial hunting cultures of North America no relationship can be stated until such time when more material has become available from Mexico.

The Tepexpan industry on the other hand, being represented by an appreciable number of implements, may provisionally be linked with certain material culture remains known from various sites in Texas from where Sellards[39] has described notched points in association with extinct mammals. That Folsom-like forms appear in this Tepexpan tool complex is in itself no sure indication for the presence of a Folsom culture because of the persistence of some of these tool types in later archeologic levels within the United States. And yet it is interesting that the flake graver found in Young Becerra alluvium at Tequixquiac reappears in the Tepexpan industry in a lake beach site which cannot be far removed in age from the former geologic formation. Further explorations will no doubt clarify such relationships. That Folsom influences extended into Mexico is perhaps suggested by the single broad point found at the San Pedro cave in San Luis Potosi. It clearly resembles the type found by Hibben[40] in the Folsom level of the Sandia Cave in New Mexico.

Much more definite are the relationships between the Chalco culture complex in Mexico and those represented by Pinto Basin, Cochise and Ventana cave sites. Striking affinities exist for instance in the group of the plano-convex scrapers of which Campbell[41] has described many which are characterized by unworked bulbs of percussion on the lower face. Of his Pinto Basin points the leaf-shaped long type with straight base resembles my own specimens. The same is true for some of the choppers and scrapers. More striking even are the resemblances to the tool

[39] E. H. Sellards, *Pleistocene Artifacts and Associated Fossils from Bee County, Texas* (1940).

[40] Frank C. Hibben, *Evidences of Early Occupation in Sandia Cave, New Mexico* (1941).

[41] William B. Campbell, *The Pinto Basin Site* (1935).

types known from the "Chiricahua" and "San Pedro" stages of the Cochise site in southern Arizona.[42] Again the plano-convex and ovoid scrapers, the choppers (called "axes" by Sayles), the thick projectile points of the dart or atl-atl group, the biface manos and flat metates are the same as those of the Chalco complex. And such typologic resemblance agrees well with the geologic time range for Antevs[43] has assigned a similar range from 8,000 to 2,000 B.C. to these fruit gathering and small-game hunting peoples of the American Southwest as I have for the Chalco culture of Mexico.

The cultural position which these peoples occupied is clearly outlined by their stone tool equipment. The typologic composition with its great variety of scrapers, its grinding stones and choppers, already suggests that the makers of these implements pre-occupied themselves not only with the chase but with the preparation of fruits and probably plant fibres as well. And since some specimens came from caliche soils one may well ask whether those people had not acquired their stone manufacture on the basis of an economy forced upon them by the drier climactic conditions which inaugurated the beginning of the Recent epoch. With forests having retreated from the vicinity of the lakes, drought resisting plants like the agave, mesquite and cactus had replaced the more luscious vegetation of the Last Pluvial. With it meat supply was diminished because the large grass eaters, such as mammoth, bison and horse, were dying out. This was the turn in the dietary habits of nomads who from now on and for thousands of succeeding years persisted on more or less the same staple foods still relished by certain North Mexican or South American (Pampean) tribes. Kirchhoff[44] has pointed out how persistent and manifold was this plant diet of the small game hunters in Mesoamerica. Their Stone Age has survived into our time and continues to determine the primitive use of stone artifacts. The collecting and grinding of mesquite seeds, the extraction of juices from the delicious tuna fruit, the de-pulping of the fleshy agave leaves with the aim of extracting its tough fibres—all these and other occupations are well known from the Indians of the dry table lands. In this type of Stone Age it was more the plant than the hunted beast that inspired the people to invent new tools with which to gain a livelihood. And in this symbiosis between Paleo-Indian and his plant world lies, I believe, one of the main reasons for the long lived conservatism of the techniques of stone manufacture. Just as the Indians of the South American pampas have clung to their accustomed modes of living over the last two thousand years while civilizations rose and fell on the eastern periphery of their vast hunting grounds, so may the peoples of the Chalco culture have persisted even into the later times when the first agriculturists rose from out of their midst. For there can be little doubt that the fruit gatherers gradually evolved the custom of

[42] E. B. Sayles and E. Antevs, *The Cochise Culture* (1941).
[43] E. Antevs, *Age of the Cochise Culture Stages* (1941).
[44] P. Kirchhoff, *Los recolectores cazadores del norte de Mexico* (1943).

planting. Any magué field in Mexico forces on the observer the picture of self-propagation through the small shoots that rise around the mother plant. And just as to-day the agave and mesquite line so many maize fields in the Mexican highlands, so may the wild maize have bordered quite naturally on the cactus studded highlands. From such peripheral plant-geographic relationships may have sprung the great revolution of agriculture which finally led to the great civilizing triumphs of the Maya and their neighbors But the quest for the origins of native American civilization can hardly succeed without placing the culture sequences into a chronologic order. This in fact is the key for a fuller understanding of the events indicated by these traces of fossil cultures first to have come out of Mexico's soil.

POTTERY SITES IN THE TEPEXPAN REGION

THE prehistory of Tepexpan does not suddenly break off with the records of the Chalco culture people but continues with an astonishing variety of ceramic remains clear up to the times of the Spanish conquest. Except for the Archaic culture period, all three major civilizations, Teotihuacanian, Toltec and Aztec are represented by a number of sites which came under investigation during a more or less continuous search for additional pre-ceramic culture localities. While none of these ceramic levels produced anything spectacular, it is nevertheless for record's sake necessary to describe briefly their distribution and archeological significance.

THE TLATÉL SITE

This is a low mound some 400 m northnorthwest of kilometer stone 6 on the highway to Tepexpan and about an equal distance west of the fossil man site. Its relative elevation above the surrounding plain is 1.5 m and the surface is littered with potsherds which weather out from distinctive layers on the periphery of the mound. To the peons the place is known as *tlatél* or *el terremoto,* the latter word referring to the disturbed condition of the soil. By origin it is an artificial mound built up from the surrounding lake flats by dumping of brown earth. The shape is oval, measuring 45 by 38 m in diameter. There is another though less elevated mound about 150 m in a northeasterly direction and potsherds may be seen also several hundred meters northwest. This distribution already suggests settlements along a lagoon which must have corresponded approximately to a lake level at 2,242 m at which depth the excavations disclosed the base of the mound. The outlines of this small lagoon are probably indicated by the same contour line (see Fig. 2). Consequently surface accumulations of sherds occur in this locality only above or at contour 2,242 m. From here Dr. Henry Field collected also a marine shell which Dr. Haas identified as *Modulus modulus*. A second specimen was found in the rock shelter refuse of Site I. Obviously this shell served for ornamental purposes as is well known from various Teotihuacan culture sites.

The excavations consisted in a trench two meters wide and 10 m long with E-W orientation on the eastern slope of the mound and in four pits measuring 2 by 2 m in diameter. At the eastern end of the trench the brown sherd-bearing soil went to a depth of 93 cm where a gray-greenish lake clay was found with no ceramic remains. Since no caliche was encountered nor any natural soil profile, it is obvious that the brown clayey earth on top was dumped on the edge of the then existing lagoon where the Totolzingo marl had previously been deposited.

Some 20 m northwest of the trench surface erosion had bared a house floor which was partly uncovered by an excavation. Remnants of rubble-enforced foundations disclosed in pit "A" the presence of several house units buried under refuse half a meter thick. The flooring consists of adobe (25-30 cm thick) containing fine gravel and superficially smoothed by a stucco matrix. No ceremonial objects were found in the refuse. We uncovered the bones of duck, a polished mano and sherds of which the majority belonged to either unpolished reddish or dark undecorated wares. Reddish polished and thin orange sherds were also found in small numbers. The second pit "B" was dug 40 m away from the first pit on the southern slope of the mound. Here sherds of the red polished type dominated down to a depth of one meter. In the following 50 cm soft earth with charcoal was found to rest on a sterile layer of the same brown earth.

Pit "C" on the western rim of the mound was rich in sherds down to a depth of one meter. The majority belonged to light brown wares with reddish and polished reddish types as accessories. Pit "D" was sunk between the two foregoing excavations disclosing a prevalence of light brown sherds with reddish polished and thin orange wares in percentages similar to those encountered in the trench.

Sr. Luis Aveleyra, of the Escuela de Antropologia, to whom the analysis of the ceramic remains was entrusted, reported to me that the mound site was occupied exclusively by peoples of the Teotihuacan II-IV phases. His conclusion is based 1) on the absence of Teotihuacan I pottery; 2) the presence of thin orange and of brown polished wares, the latter with red decoration on brown, both types characteristic for Teotihuacan II; the dominance of light brown and reddish domestic wares of common manufacture typical for Teotihuacan III. This level is indicated also by a small clay mask of classic Teotihuacan type. Intrusive ceramic remains of Coyotlatelco, Matlacinca and Aztec II-IV periods indicate not only considerable disturbance of the mount stratification but its more or less continuous habitation. The remains of houses belong to a Teotihuacan period.

Important is the absence of Teotihuacan I on this mound, which I take to indicate that the necessity for its construction had not yet arisen during that period. Considering that Noguerra[45] excavated a habitation site of this phase near Chimalhuacan on the eastern valley margin from a depth below that of present Lake Texcoco, a lower lake level must be assumed (Fig. 8, Phase III) which undoubtedly obliterated the Tepexpan marsh for a short time. When the lake rose again a small lagoon formed which induced the Teotihuacan folk of the succeeding culture periods to establish a small fishing and hunting community on its swampy shores. From then on (e.g., the first centuries after Christ) the mound must have been settled or visited time and again until almost up to the Spanish conquest.

The mound site therefore embraces a time span of almost one thousand years during which the margins of the Tepexpan lake flats were occupied by peoples to

[45] E. Noguerra, *Excavationes en el tepelcate, Chimalhuacan, Mexico* (1943).

whom the lake had offered the advantages of hunting and fishing. It is not surprising, therefore, if the other small test excavations on the hillsides north and northeast of the mound disclose the same lengthy record of pre-Spanish occupation.

BLUFF SITE NO. I AND III

Site I is a small rock shelter below the basalt bluff 250 m north from the terminal of the westermost village road of Tepexpan. At first this site seemed promising enough because from here a commanding view is had over the lake flats and the bluff provides some shelter from the cool north winds. The rocky roof extends only half a meter from the bluff and was found blackened by soot from campfires. Yet the test excavation disappointed my expectations of a pre-ceramic site since the soil proved to be only 13 inches thick on basalt rubble. In the first 3 inches charcoal pieces and ash were mixed with a few sherds consisting both of incised Aztec and Coyoltatelco wares, the latter showing zigzag pattern in red on a cream colored slip, characteristic for this culture. Below was a disturbed burial of a child associated with brown incised and polished black potsherds. One small clay mask of classic Teotihuacan type and a clay figurine of a chameleon, three burnished ear plugs of clay and some obsidian artifacts were closely associated with the burial. The mask and the brown incised ware indicate a Teotihuacan burial probably of the third period.

While it is possible that the sterile bottom stratum of basalt boulders originated merely from collapse of the roof of the shelter, a deeper excavation was ruled out by virtue of the solid lava rock which appeared within a few inches of the sherd bearing soil.

Site II also is a rock shelter, 350 m northwest of site I (Pl. 20, c). Here the soil was even thinner containing Aztec and Coyotlatelco sherds but no Teotihuacan material.

The third bluff site lies thirty meters to the west. Here a trench was made in order to determine the composition of a small fan which issues from a small arroyo in the basalt bluff. At a depth of 3 feet, 2 inches brown basalt ash was encountered and and calichized basalt detritus. The overlying soil displayed an ash layer at the base covered by refuse in which Aztec and Coyotlatelco sherds dominated.

South from here a fourth excavation was made chiefly for the purpose of finding the Zacatenco beach formation. At first a pit was dug measuring 22 by 13 feet in diameter and 2 feet deep. From here a trench was made 40 feet up the hillside and almost 6 feet deep. The trench disclosed the following stratification:

Gray soil with few sherds and some basalt boulders, 6-10 inches.
Rounded basalt pebbles, 4-6 inches.
Brown clay sand, 3 feet 3 inches.
Dark almost blackish basalt ash and pumice with limonitic layer along contact with sand, 1-2 feet.

This section proves the superposition of sherd-bearing refuse of the Aztec and Coyotlatelco periods over water rolled basalt debris which bears a marked white coating typical for the shingle of the Zacatenco beach (2,248 m). The basalt ash is the same as on the adjoining Tlalhuilco crater hill so that its eruption can now confidently be placed into a stage preceding the recent beach, that is to say, the eruption must have taken place either during or shortly before the caliche formation. In this connection it is interesting to recall the presence of pumice at the base of the caliche in the fossil man site at Tepexpan.

The crater hill with its commanding position above the lake flats must have attracted the Indians throughout the centuries and yet its slopes are barren of archeological remains.

At first I had hoped that some caves of which the Tepexpan people had told me would at last furnish a clue for some camp sites of Tepexpan Man, but the only cave which might have offered such a chance produced nothing more than a small sherd collection of the same composition as the bluff sites. This cave is situated almost on top of the hill on the southern upper slope and is merely an opening in the volcanic breccia with an entrance 9 feet wide and a cavern measuring 30 by 40 feet in diameter. Its ceiling is broken in parts so that few original roof remnants are left to show a coating of black soot from camp fires. The test excavation disclosed a layer of ash and charcoal at 18 inches from the cave floor with typical Teotihuacan sherds of brown and thin orange wares. This layer was only 3 inches thick and underlain by sterile volcanic ash and pumice.

The conclusion to be drawn from these scattered archeological sites is that Tepexpan by virtue of its favored position on the old lake shores was settled more or less continuously. Burials of Archaic period were found only two kilometers distant at Cuanalan so that even the more remote ceramic ages have left their impact in this vicinity. Yet so far we have no traces of a definite camp site of earlier folk except those surface accumulations of artifacts tentatively described as the "Tepexpan industry." These cannot have been manufactured below the basalt bluffs because of the recent age of the soils encountered in my test excavations. But since a considerable number came from higher slopes it is suggested that the camp sites of Tepexpan Man lay above the bluffs and that subsequent tilling as well as surface erosion may have obliterated their traces.

THE CARVED BONE OF TEPEXPAN

AMONGST the fossil material from Tepexpan is an extraordinary fragment of an elephant tooth which was carved into a miniature human foot (Pl. 21). It was given to my assistant, Señor Luis Aveleyra, by the foreman of our excavation crew, who, in turn, acquired it from a young man in the village. While the exact circumstances of its find and the locality are unknown, it is nevertheless possible to assign it to a known geologic formation because of the specific type of matrix preserved in the recesses. For this reason I am inclined to regard it as a sculpture to be associated with fossil man in the Valley of Mexico. Startling as this statement may seem, it should be remembered that this is not the only one of its kind, for Barcena[46] described the carved bone of a fossil llama from a bone bed near Tequixquiac which he regarded as of Pleistocene age. While this specimen was lost and removed from all scientific scrutiny, the Tepexpan figure presents a challenge and poses a problem second only in importance to the discovery of the Tepexpan Man.

The figure is carved out of a small fragment of an elephant molar. To be more exact, the fragment is part of the crown of a tooth, so characteristic for the large grinding teeth of the mammoth, the jagged ridges of which not unfrequently are so deeply clefted in mature specimens that they detach themselves either in the process of fossilization or by artificial means. In either case a platy fragment of tooth will result with rather smooth surfaces and its inner structure will display the type of cross section illustrated by our specimen (Pl. 21, c), in which the outer brown enamel layer of fibrous texture overlies the inner ivory colored dentin with a thin blackish stained enamel layer intervening. On this side the crown fragment suffered a later fracture. The specimen is 4 cm long, 2 cm wide and 0.7 cm thick.

Intentional carving is clearly seen on both sides. On both surfaces (A, B) the longest and deepest incision appears between the large and second digits where the enamel was incised over 0.8 cm long in prolongation of the thin cleft in the surface of the lamella. A correspondingly long scar appears on the concave side (A) between the third and fourth digit so that between these two incisions the surface is raised reminiscent of a foot pad. The great toe is suggested by the broadest knob-shaped digit so that the figure is that of a right human foot. Since the other side (B right) shows a relatively fresh fracture, the small toe was broken off. The ends

[46] M. Barcena and A. C. del Castillo, *El hombre del Peñon* (1885).

of the digits on the under side (A) have the characteristic padlike shape of human toes and in their order their respective lengths are anatomically correct.

The manner of carving obviously took account of the natural cleavage of the enamel surface and proceeded from there downward though the great toe was especially carved so as to give it the broadest possible size (A). The instrument employed by the sculptor can only have been a stone graver, pointed and sharp, and made of either quartz, chalcedony or a piece of volcanic glass all of which rocks were the favored raw material in the manufacturing of stone implements as illustrated by the San Juan artifacts or the Tepexpan industry.

Now, it is of course possible that the figure was not carved out of the fresh tooth but at a time when its original hardness had been lessened by fossilization. This would have made the carving easier, but the fact is that small remnants of the original sedimentary medium not only cling to what might have been natural recesses in the enamel but to the artificial incisions as well. In my judgment this indicates that carving preceded or was at least contemporary with a process of sedimentation which produced the fine sand still clinging to the recesses of the figure.

The claim for antiquity rests on three separate considerations. First the mineralogic composition of the sandy matrix. This is a fine sand composed of volcanic glass, feldspar and dark minerals such as appear as main constituents of the El Risco sand near Tepexpan. Some of the mammoth bones found there have the same fine gray sand clinging to them. No other member of the Quaternary geologic formations has such a characteristic color and composition. Second, there is the choice of the raw material, most unusual for a region where clay, rock or human bone were the favored materials for the indigenous artists. Indeed one might suspect that people maintaining close connections with big game animals such as elephants, would quite naturally have chosen their bones for carving in the traditional manner of the Stone Age hunters in Europe where reindeer and elephant bons were used quite frequently for a portrayal of hunting scenes or of special symbols arising from animistic beliefs. A final third argument arises from the fact that the figure came from the Tepexpan region where the antiquity of man reaches back through the ages longer than at any other locality known so far in Mexico. And it is here where fossil bones occur in a sandy unit of the Pleistocene and where peons now and then pick up these strange looking objects out of curiosity for the ancient history of their native land.

If these considerations lead me to suggest an Upper Pleistocene age for this figure, it is with the conviction that this age, as any of the succeeding periods, saw the primitive hunters endowed with an artistic urge to portray themselves and their habitat.

NOTE ON SOME BONE ARTIFACTS FROM TOTOLZINGO

The find of the little bone sculpture prompted me at the beginning of the summer of 1948 to search again in the sandpits near Totolzingo for traces of former human occupancy. This search yielded three small bone tools, a chisel and two awls, which I extracted from the fossil bearing sand of the El Risco beach I. The two awls have identical dimensions (5.2 cm long and 1.2 cm wide) and an analogous shape (Fig. 15A, 1 and 2). They were made of the bone of some mammal and show clear traces of polish at the pointed ends. The gray sand adhering

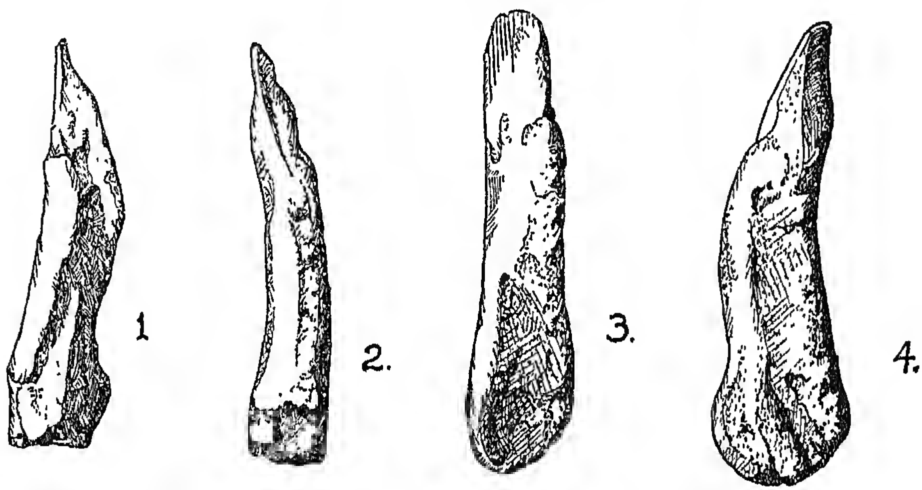

FIG. 15A. ARTIFACTS

1 and 2, awls of identical dimensions and analogous shape. 3 and 4, front and side views. From the sandpits near Totolzingo.

to them was slightly calichized, a fine calcareous incrustation covering most of the bone surface. The chisel shows polish one-and-one-half cm. from the top downward with the same gray sand adhering to its surface, except that in this instance the sand shows in spots an ochre color (Fig. 15A, 3 and 4, present front and side views).

The presence of bone implements in the beach sand fully confirms the statement previously made as to the Upper Pleistocene age of the little sculpture, in as much as all these artifacts occurred in the oldest of the El Risco beaches which marks the high water level of prehistoric lake Texcoco at the maximum of the last Pluvial. Considering that the artifacts from Tequixquiac are of similar age there can be little doubt as to the presence of early man several thousand years prior to the Tepexpan Man.

THE PHYSICAL ASPECTS OF TEPEXPAN MAN

JAVIER ROMERO

INTRODUCTION

AS pointed out by Dr. de Terra, the geologic position of the Tepexpan remains indicates great antiquity, possibly 11,000 years, and constitutes the first authentic claim for the presence of Fossil Man in Mexico. For this reason it was thought advisable to undertake a special study concerned with the proper identification of the physical features, a task which was entrusted to me as a physical anthropologist at the Museo Nacional de Antropologia de México. With the aid and approval of the Viking Fund, Dr. Daniel F. Rubín de la Borbolla, Director of the Museo Nacional, commissioned me in the summer of 1947 to bring the fossil remains of Tepexpan Man to the Smithsonian Institution of Washington for proper study.

The writer is greatly obliged to Dr. Paul Fejos, Director of Research of the Viking Fund, for the financial aid rendered in this connection. I am also greatly indebted to Dr. Alexander Wetmore, Secretary of the Smithsonian Institution; Dr. F. M. Setzler, Head Curator of the Department of Anthropology of the same institution; and especially to Dr. T. Dale Stewart, Curator of the Division of Physical Anthropology, for their valuable help and suggestions. To Dr. M. T. Newman of the same division I also wish to express my heartfelt thanks. Of very real help during the reconstruction was the assistance rendered by Miss Lucile Hoyme and Mr. H. Jackson and by the photographic and casting laboratories of the Smithsonian Institution, where the illustration of the restored skeletal parts and casts of the skull were made.

Since this section includes also the reports of others to whom opportunity to study the bones was given, I wish to thank those colleagues who at one time or another have contributed studies: Dr. Franz Weidenreich of the American Museum of Natural History; Drs. William Boyd and William Laughlin of the Boston University School of Medicine and Harvard University, respectively; Dr. Samuel Fastlicht of Mexico City; and Dr. C. J. Connolly of the Catholic University of America. I am also grateful for valuable suggestions given me by anthropological scholars whom I met in Washington, New York and Boston.

COMMENTS ON THE DISCOVERY

ON February 22, 1947, I was notified by Dr. de Terra that he and Engineer Arellano had just discovered a human skull at one of the sites which Dr. Lundberg had designated for excavation. I went immediately out to Tepexpan where I found my colleagues standing in an excavation pit with the skull still resting in the place where it had been first discovered. However, for purposes of identification, the skull had been removed and then replaced so that the visitors might see it in situ. I learned from the excavation crew that some bone fragments had been removed. Closer examination convinced me that the skull and the layers in which it was found showed no signs of intrusion.

The bones appeared at a depth of 107 cm as measured from the surface to the highest point of the skull (Fig. 16). Nevertheless, the other bone fragments had been found apparently at a slightly greater depth, so that the skeleton appeared to occupy a somewhat inclined position.

On the following day I started excavating the remainder of the skeleton with the assistance of Dr. de Terra and Engineer Arellano. The bones were embedded in wet, brown clay, making the extraction of the smaller bones somewhat difficult. Plates 22 and 23 show the skull in its position and Plate 24 illustrates the orientation of the skeleton during excavation. Upon completion of the task I drew a sketch (Fig. 17) showing the position of the skeleton.

Considering that in the course of the first excavations a few bones had been removed, I decided to make a thorough search in the earth previously removed from the pit. I waited for a few weeks until the soil was dry, then proceeded to sift all the soil around the site in order to make sure that we would recover whatever bones had been left in the ground. In this manner I managed to collect a considerable number of bone fragments such as innominate, sacral fragments and a few foot bones, all of which must have been originally in position, since pelvis and foot bones had been close to each other.

The position of the skeleton revealed that the vertebral column, scapulae and most of the ribs were missing. The few rib fragments found appeared to be deviated from their normal anatomical relationships. This absence of vital parts of the skeleton leads me to believe that probably both the corpse and the skeleton had previously been exposed for a considerable time.

The position of the skeleton (Fig. 17) shows that the individual was flexed, the frontal plane of the thorax facing down. The knees were to the right of the sagittal plane and the elbows to the left. The orientation was northeast to southwest. The left palm was turned up toward the thorax, while the right one was placed downward.

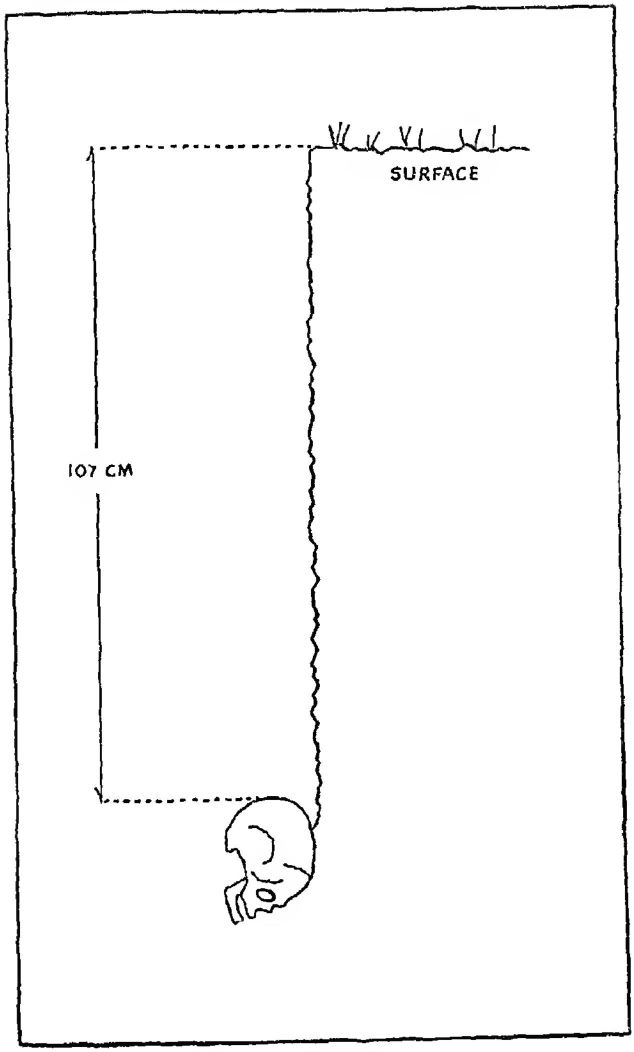

FIG. 16 SKELETON IN SITU

Sketch showing the depth at which Tepexpan skeleton was found, and the original position of the skull.

The skeleton was found without any association of pottery or implements, the only organic remains in the clay were those of plants.

After every bone had been carefully removed, the pit was enlarged to the dimensions shown in Plate 22, yet no other remains came to light except the small bone of a water bird, as mentioned by Dr. de Terra (p. 43). We tried to deepen the excavation, but at a depth of 30 cm encountered groundwater in such profusion that no further results were possible.

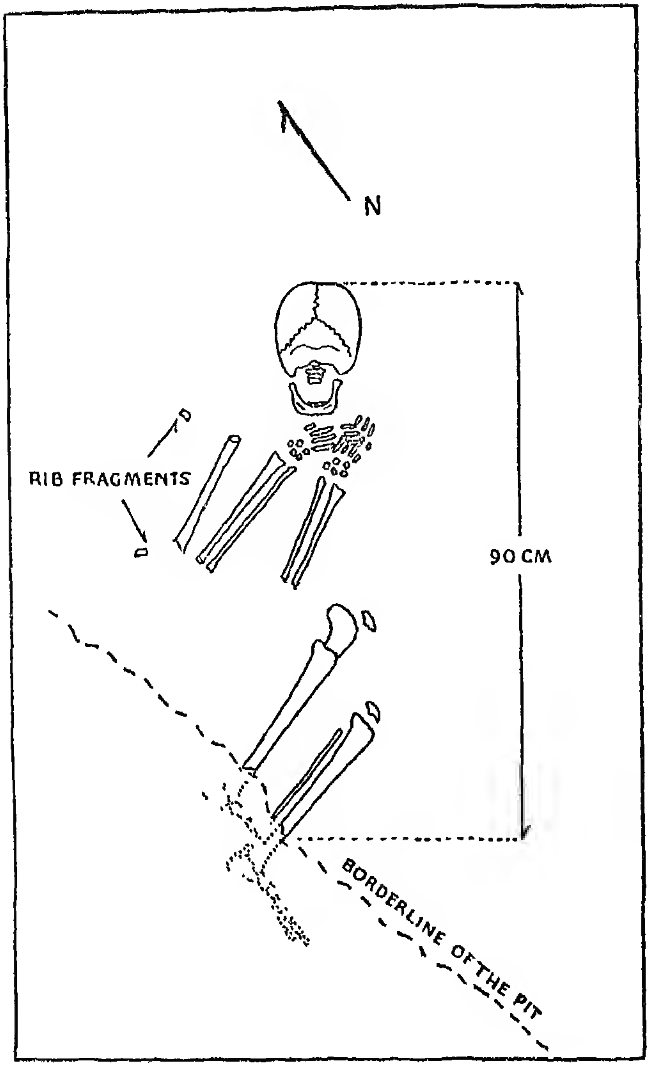

FIG. 17. POSITION OF SKELETON

Sketch of the position of skeleton as it was found. The deviation of the rib fragments and the absence of almost all the vertebral column, ribs and scapulae can be seen. Fragments of the sacrum, innominate, tali, and other foot bones were found together, suggesting that the legs were flexed so that the feet were near the pelvis.

The skeletal remains were brought to the laboratory of the Physical Anthropology Division of the Museo Nacional de Antropologia in Mexico City, where a preliminary study was undertaken.

PRELIMINARY WORK

IN the preparation of the bones I was aided by the Director of the Museum, Dr. Daniel F. Rubín de la Borbolla, and all the members of the department staff. Each bone was cleaned and a detailed inventory made. This inventory is given in Appendix A. The cleaning method used consisted in removing the clay matrix with moistened pieces of cotton. After drying, the bones were immersed in a very thin solution of ambroid for better preservation. This was a precautionary measure, for actually the bone substance was sufficiently fossilized to guarantee preservation.

While these operations were under way, the Director of the Museum thought it advisable to obtain the opinions of eminent anthropologists as to the most efficient manner of study and preservation. Dr. Franz Weidenreich and Dr. T. Dale Stewart were invited to come to Mexico. Dr. Weidenreich gave a preliminary opinion as to certain anatomical characteristics and techniques of preparation. On the last day of his visit a discussion was held on the subject of fossil man in which Dr. Weidenreich, Dr. Rubín de la Borbolla, Dr. Martínez del Río, Dr. de Terra, and Engineer Arellano participated. The outcome of Dr. Weidenreich's preliminary examination was a report which is appended herewith (Appendix B) although it has already been published in the preliminary statement by de Terra.

A few weeks later the staff of the department was favored by a visit from Dr. Stewart, who had been engaged in field work in Guatemala. His preliminary report appears in Appendix C. His ultimate judgment as to the relations of Tepexpan Man to other early finds appears in another section.

While engaged in cleaning the skull, I noticed that certain abnormal features in the dentition called for a special study and called upon Dr. Samuel Fastlicht, an eminent orthodontist in Mexico City, to undertake such a study. He had previously rendered invaluable service by examining the dentition of pre-Columbian skulls. He took several x-ray pictures in his own laboratory and submitted his report which is here given in Appendix D.

In the course of all these preliminary studies it finally became desirable to carry out the full restoration and study at a place where comparative material was available and where exchange of opinions would be possible. In our judgment there was not a better place than the Smithsonian Institution of Washington. Dr. Alexander Wetmore sent a most cordial invitation for us to work there and thanks to the cooperation of the Mexican government and the support of The Viking Fund, it was possible for me to bring the fossil remains to the Smithsonian Institution where I carried out the examination of the remains.

THE RESTORATION

THE first task was the restoration of the bones. This was somewhat difficult owing to the fragmentary condition of the skeleton and the bones. Plates 20 and 21 convey the impression that the skull was complete when, in fact, the facial portion was partly preserved only because it had become attached to the skull cap, a process which was undoubtedly due to the soft consistency of the clay matrix. The leg bones, which had previously undergone some dislocation, were also fragmentary.

The identification and fitting together of the many bone fragments required much time and patience. Consolidation was made only after Dr. Stewart and myself felt convinced of correct placement. Ambroid solution was used for consolidation of joints, and a special substance known as "Savogran crack filler" was used in certain places requiring actual replacement of missing bone In such instances, a careful comparison was first made with analogous bones of similar size selected from the ample collections of the Division of Physical Anthropology of the U. S. National Museum.

The last portion to be restored was the skull. This had to wait until Dr Stewart's work of making the endocast was finished. The endocast was really a piece-mould made by filling first a small portion of the brain cavity with plaster and repeating the process as each part hardened, taking due care to use a separator. Then finally all the pieces could be removed from the skull and assembled (see Pl. 25). Comments on the endocast are to be found in Dr. Connolly's report in Appendix E.

This work finished I proceeded with the restoration of the facial portion. As mentioned previously this part was in fragmentary condition and detached from the skull. In this difficult task two methods were employed; one making use of the Schwarz stereograph for control of asymmetries, and the other a comparison with complete skulls of similar sex and age selected from ancient skulls in the museum collections. In this manner I arrived at a restoration which met with the approval of Dr. Stewart and Dr. Newman and which represents in our judgment the best representation of the physical type of Tepexpan Man (see Pls. 26 and 27).

In order to get an approximate estimate of the physical stature of Tepexpan Man it was necessary to measure the long bones. This was done by drawing their anterior surface outline by the stereograph, orienting each bone as if the maximum length were to be obtained by the osteometric board. However, since only two of these bones were complete, it was necessary in most cases to determine the inclina-

tion and correct position by comparing the fragments with complete specimens of analogous size and individual age. I measured the height from several points of the bone fragments to the horizontal base of the stereograph. In this way I obtained the most probable outline of both humera, left ulna and radius, of both the femora and tibiae, in addition to those of the right ulna and radius, which were almost complete (Fig. 18). When the bones were broken, I attempted to complete their outlines by comparison with other complete bones selected from the museum collections because of their identity in sex, size, and age. After this was done, drawings were made of the specimens thus chosen and these supplied the missing parts. The missing portions were indicated with dashed lines. All drawings were measured at various levels and then compared with the actual measurements of the bones.

SEX CHARACTER

From the beginning it appeared to me and to all others who studied the skeletal remains that they belonged to a male individual. The heavy muscle attachments as shown on the deltoid ridges of the humeri, the linea aspera of the femora and the popliteal line of the tibiae are male characteristics. Unfortunately, we have only one small fragment of the innominate, so I am unable to make use of the greater sciatic notch as a criterion for the male sex. Neither could I use the size and shape of the pelvic cavity. The inclination of the femora is not sufficiently marked to raise doubts about the male sex.

As for the skull, the brow ridges and the mastoid processes are of average development. The muscle attachment surface in the nuchal region is not very marked, whereas the superior occipital line is developed into the form of a true torus. But the shape of the forehead and the foramen magnum seem to indicate a male, while the same may be said of the chin and angle of the lower jaw, of which only the left side is complete. I therefore agree with Dr. Weidenreich's viewpoint as set forth in his report: "None of the bones is very robust; on the contrary, they rather appear to be of a generally fine structure. Although this suggests female sex, the strongly developed muscular tuberosities prove that the individual was a male" (see Appendix B).

This sex determination is not supported by any associations with material culture objects or burial characteristics, such as have frequently aided us in Mexico in a proper determination of sex characters in pre-Columbian burials.

DEGREE OF MATURITY

The state of ossification of the bones is complete. On the other hand, a certain degree of exostosis was noted on the left lower articular surface of the epistropheus, as well as on the atlas surface where the odontoid process fits (Pl. 29). On the preserved basilar surface the suture is closed and has disappeared. A most striking feature of the dental process is the abrasion, described in detail by

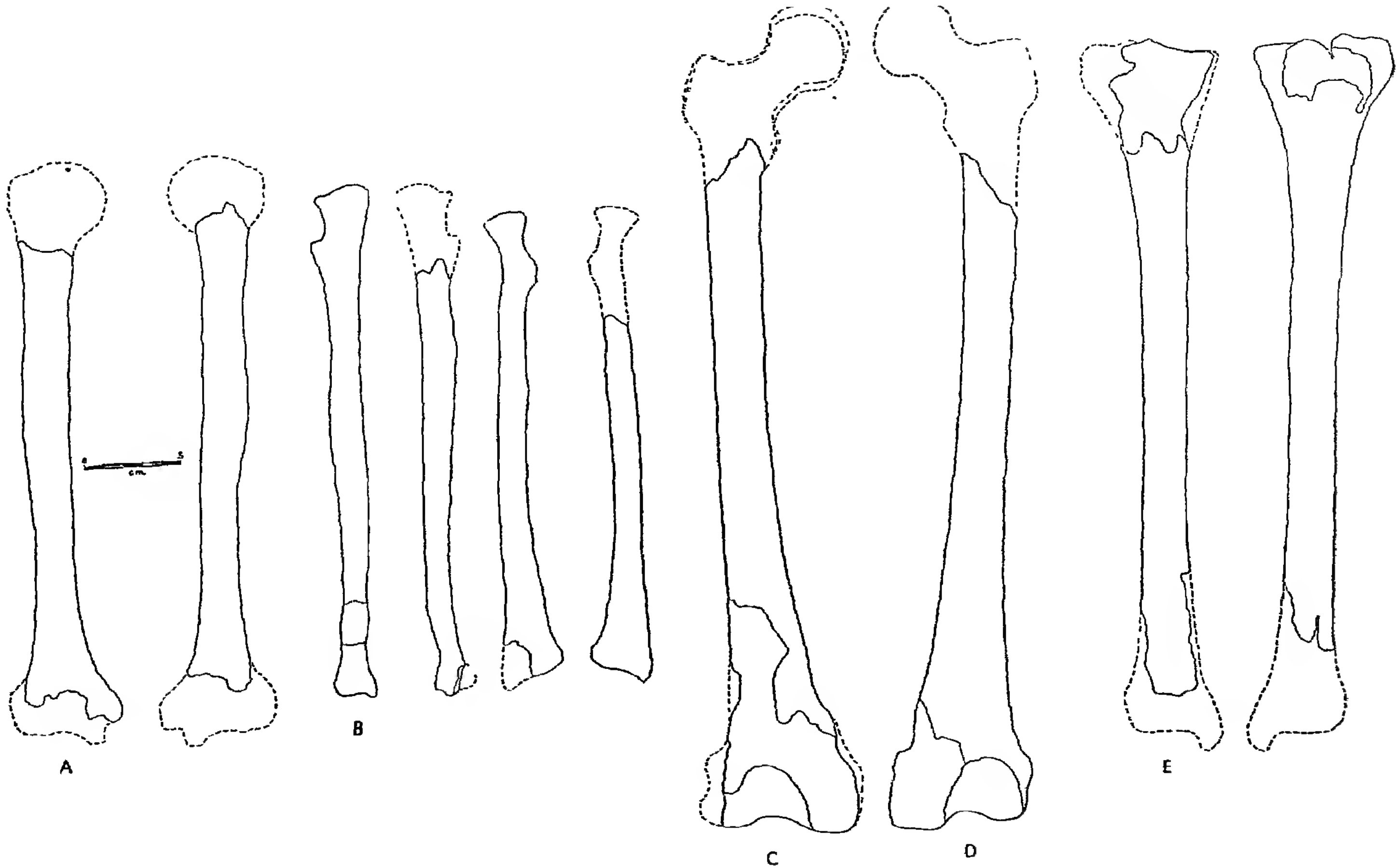

FIG. 18. STEREOGRAPHIC DRAWINGS OF THE LONG BONES. (The fibulae were not drawn because they are very fragmentary.)

Dr. Fastlicht (Appendix D) who maintains that this was caused by the heavy mastication called for by the diet of that time. Such a viewpoint would seem to be corroborated by similar abrasion features found on many skulls collected previously from the pre-ceramic "Indian Knoll" site in Kentucky, which specimens I studied in the museum collections in Washington. In this case abrasion is very marked, not only in fully mature but in adult and sub-adult specimens as well. Hence, it seems

TABLE 3. SUTURE CLOSURE
(Aging based on T. W. Todd's white standards)

Endocranial		
Coronal	Completely closed	more than 42 years
Sagittal	" "	more than 35 years
Lamboid	" "	more than 48 years
	(The lamboid suture is definitely closed)	
Ectocranial		
Spheno-parietal (R)	closing rapidly	less than 65 years
Spheno-temporal (R)		
Anterior	apparently still open	less than 67 years
Posterior	" " "	less than 67 years
Masto-occipital		
Inferior	closed	less than 72 years
Median	?	
Superior	?	
Parieto-mastoid	?	
Spheno-frontal		
Greater wing	closed	about 65 years

reasonable to assume that this feature of excessive dental wear has no cause but that cited by Dr. Fastlicht. Leigh[1] has also suggested that diet may have been the cause of the dental wear in the specimens from "Indian Knoll."

In the Tepexpan skull only a few teeth are preserved. Considering the results of the radiographic examination by Dr. Fastlicht, I concur with his view point when he states: "The degree of abrasion and the density of the bony tissue observed in the jaws as well as in the radiographs, leads us to believe that this was a person of advanced age" (see Appendix D).

The degree of obliteration of the sutures is used as a criterion for age determination, as shown in Table 3, as calculated by Dr. M. T. Newman.

Dr. Newman states: "Standards for endocranial and ectocranial closure are those of T. W. Todd. Since they are based on a male, white dissecting-room

[1] R. W Leigh, *Dental Pathology of Indian Tribes* (1925).

population, their application to American Indians is probably not wholly valid. Observations were made in strong natural light under a magnifying glass.

"The coronal, sagittal, and lamboid sutures are completely closed. On the basis of Todd's standards, Tepexpan Man was more than forty-eight years old. Both portions of the spheno-temporal are still open, which would make the specimen less than sixty-seven years old. However, the inferior portion of the masto-occipital suture and the greater wing of the spheno-frontal suture are closed. These reach a peak of closure at seventy-two and sixty-five years respectively, but in individual cases may close earlier.

"Since the standards are not wholly satisfactory and the margin of error relatively great in aging skulls of advanced age, *fifty-five to sixty-five years is the present best estimate.*"

STATURE

As a basis for estimation of stature, I used the drawings of the long bones previously mentioned. It must be recalled that these drawings were made by comparing the Tepexpan bones with those of other complete specimens. However, in the case of the femora there was difficulty in determining the true femoral angle (the angle between the axis of the shaft and that of the femoral neck).

The possible range is shown in Fig. 18, where it can be seen that the resulting variation in height is about 1 cm. However, once the drawings were considered as satisfactory, the computation of maximum length was based on them. In regard to the maximum and bicondylar lengths of the femora I took an average of all possible variations of form of the upper portions. With these results I have constructed Table 4, in the lower part of which we find the stature values derived from Manouvrier's tables.[2]

To use such tables I followed Manouvrier's own instructions; that is, I looked for the value which would include each of the original measurements, adding to each measurement 2 mm. Then, 2 cm were subtracted from the final result. From the right ulna and radius, which were the only ones recovered complete, or which needed very slight restoration, we get a stature of 173 cm. When the average is obtained, including those reconstructed in drawings, the figure drops to 168 cm. In other words, we have a difference of 5 cm.

However, for further consideration on this matter, I used Pearson's[3] method. In this case I followed the same procedure. The right radius (Pearson does not consider the ulna) gives a stature of 170 cm. The average of the ten formulae is 167 cm, as can be seen in Table 5.

In the lower part of Table 5 I have combined the figures that were obtained

[2] L. Manouvrier, *La Determination de la taille d'après les grands os des membres* (1893).

[3] K. Pearson, *On the Reconstruction of the Stature of Prehistoric Races* (1899).

from the two procedures. It may be seen that the stature derived from the two complete bones is greater than either of the two averages. The difference as regards the use of Manouvrier's tables is 5 cm and the difference according to Pearson's method is 3 cm. Such a difference may be due to the failure in getting the true bone lengths. But it must be pointed out that the two methods do not result in the same figure when the one complete bone is used.

So the problem is to determine which procedure is to be considered best and whether more reliance should be put on figures derived from one complete bone or on those derived from the reconstruction drawings of all of them.

TABLE 4. STATURE (Manouvrier)

Maximum lengths taken on the bones		
Right ulna		278 mm.
Right radius		258 "
Maximum lengths taken on the drawings		
Humera: right		316 mm.
left		318 "
Left ulna		277 mm.
Left radius		258 "
Femora: right		a) 434 b) 442 c) 447 mm.
left		447 mm.
Tibiae: right		377 mm.
left		380 "
Stature calculated from Manouvrier's tables		
Right ulna		173 cm.
Right radius		173 "
	Average of lengths	*Stature*
Ulnae	277 mm.	175.4 cm.
Radius	258 "	175.4 "
Humera	317 "	164.4 "
Femora	444 "	166.6 "
Tibiae	378 "	169.7 "
Average		168 3 "

First of all Manouvrier's tables have been formulated for a specific human group and their use cannot be universal. On the other hand, Pearson's mathematical elaboration, based on Rollett's and Manouvrier's work, has certain limitations, as Pearson himself has stated with reference to Stevenson's paper: "I am

prepared to admit that better results for the regression formulae will be obtained by applying the formula peculiar to a race itself than by applying a formula arising from a second race. . . ."[4] Moreover, this same limitation has also previously been pointed out by others.[5]

Therefore, we do not know to what extent these procedures can be applied to the several human groups, particularly to those from the pre-Columbian Americas. For this reason we have found it very useful to measure the stature directly on

TABLE 5. STATURE (Pearson)

Stature calculated from Pearson's Method	
Right radius	170.3 cm
Formula 1	165.0 "
" 2	162.0 "
" 3	168.2 "
" 4	170 3 "
" 5	178 1 "
" 6	166.4 "
" 7	166.1 "
" 8	162.3 "
" 9	163.4 "
" 10	173.8 "
Average	167.5 "

Comparison of the results	*Manouvrier's tables*	*Pearson's Formulae*
Right radius	173 cm.	170 cm
Average including the lengths taken on the drawings	168 cm.	167 cm.

Mexican pre-Columbian burials. Of course, this has been done when the preservation and position of the skeletons has permitted it. I recognize that this is only an approximation, but undoubtedly in several cases it has been useful as a means of comparison with the results obtained by the use of Manouvrier's tables.

Unfortunately, it was not possible to take such a measurement in the case of the Tepexpan skeleton in view of the position in which it was found (see Fig. 17) and the ancient loss of certain parts. So, from the evidence in Tables 4 and 5 we can be no more definite than to conclude that the stature of the Tepexpan

[4] H. P Stevenson, *Anthropometric Differences in Stature Long Bones Regression Formulae* (1929), 319.

[5] M. T. Newman and C. E. Snow, *Preliminary Report on the Skeletal Material from Pickwick Basin, Alabama* (1942), 421; T. D. Stewart, *Anthropometric Observations on the Eskimos and Indians of Labrador* (1939), 61-69.

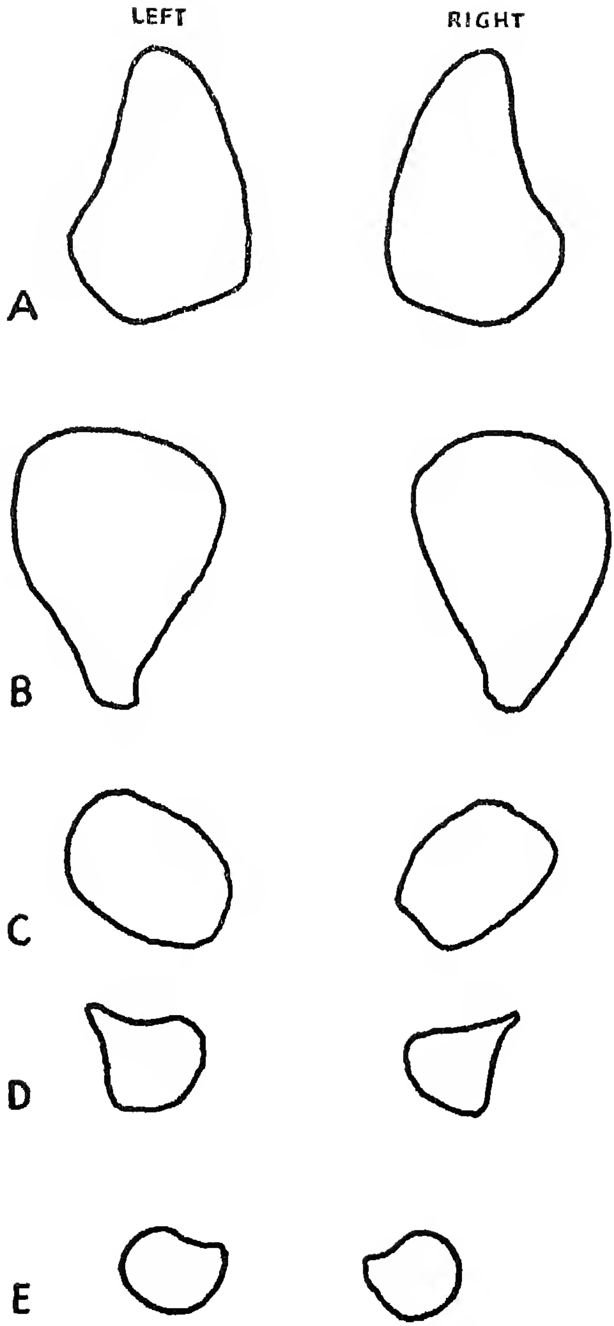

FIG. 19. CROSS-SECTIONS OF THE LONG BONES AT SHAFTS

A, tibiae. B, femora. C, humera. D, ulnae. E, radius. Mid points were calculated by means of the stereographic drawings.

individual was probably somewhere between 167 and 173 cm. However, as the average of the four final figures is 169.5, it seems to me that this man's stature was about 170 cm.

If this figure is acceptable, Tepexpan Man was taller than the average pre-Columbian and modern Mexican Indian populations. With the exception of a few skeletons from northern Mexico, we find 160 cm for the pre-Columbian males, and 162 cm for the modern Indian groups. The second figure is obtained from a number of studies of Indian groups by Mexican and foreign investigators.[6]

We cannot, of course, make any accurate estimate of the average stature of the group to which Tepexpan Man belonged on the basis of one skeleton, as stature is one of the most variable physical traits of any human group, as shown by standard deviations and coefficients of variability.

THE MEASUREMENTS

Almost all the standard measurements were taken, both on the long bones and the skull in order to present a complete description of the remains. All of them were checked by Dr. Stewart and, to complete the next table, the measurements taken on the drawings were included.

Table 6 shows also all the indices calculated for each bone. The asterisks mark the measurements taken indirectly, that is, taken on the drawings, and indices calculated from them. Fig. 4 shows the cross sections at the midpoint of each shaft. To get these cross sections, I moulded a narrow strip of hot wax around the shaft. Adjusting it to the bone, I made a cut horizontally around it, on the lower border. The ring thus obtained was cut vertically to remove it from the bone, after which it was closed again while still pliable. Once cooled, the horizontal edge of the strip was smoothed and applied to the paper to draw the contour. The maximum and minimum diameters were checked on the bones.

The right femur is eurimeric (index 87.10). It shows a character uncommon among the American Indian bone series. However, the maximum subtrochanteric diameter is only approximate, so that the datum may not be very accurate. Neither a hypotrochanteric crest, third trochanter nor hypotrochanteric fossae are present. The linea aspera is very prominent and the degree of curvature in the shaft is medium.

The right tibia is platicnemic (index 60.00) and the left one mesocnemic (index 65.71), in other words, rounder than the average for American Indian series. Although the bones are fragmentary, it is evident that the retroversion is not very marked and the shaft curvature is medium. The degree of roughness of the muscular attachments is rather marked.

The right ulna presents a healed fracture on the lower part of the shaft. Apparently the fracture occurred during adult or sub-adult life. The right radius

[6] J. Romero, *La Poblacion Indigena de Tilantongo, Oax.* (unpublished).

TABLE 6. MEASUREMENTS OF TEPEXPAN HUMAN REMAINS

	Right	Left
HUMERA		
Max Length	316 mm.*	318 mm *
Diam. major at Middle	22 "	21 "
Diam. minor at Middle	17 "	16 "
Index at Middle	77.27	76.19
Circum. of the shaft	65 mm.	61 mm.
Index of robusticity	20.57*[1]	19 18*
ULNAE		
Max. length	278 mm.	277 mm.*
RADIUS		
Max. length	258 "	258 "*
Circum of the shaft	40 "	39 "
FEMORA		
Bicondylar length	442 mm.*	447 mm *
Max. length	443 "*	449 "*
Diam. lateral max. at upper flattening	31 "*	31 "*
Diam. anteroposterior min. at upper flattening	27 "	
Diam. max. at Middle	35 "	34 "
Diam. min. at Middle	26 "	26 "
Index of Platymery	87.10	
Index at Middle	74.28	76.47
Circum. of the shaft	95 mm.	96 mm.
Index of robusticity	21.44*	21.38*

	Right	Left
TIBIAE		
Length (less Spine)	377 mm.*	380 mm.*
Diam. anteroposterior max. at Middle	35 "	35 "
Diam. lateral min. at Middle	23 "	23 "
Diam. max. at nutricious foramen	40 "	38 "
Diam. min. at nutricious foramen	24 "	25 "
Index at Middle	65.71	65 71
Index of Platycnaemy	60 00	65 79
Circum. of the shaft	93 mm	93 mm.
Index of robusticity	24.67*	24.47*
PATELLAE		
Max. Height	42 mm	42 mm.
Max Breadth	46 "	46 "
Max. Thickness	21 "	22 · "
Breadth-Height Index	109.52	109.52
Module	36.33	36.67
TALUS		
Max. Length	56 mm	58 mm.
Max. Breadth	43 "*	44 "*
Max. Height	31 "*	32 "
Breadth-Length Index	76.78	75.86
Height-Length Index	55.36*	55.17
Module	43 33	44.67

* The indices of robusticity were obtained by means of the maximum lengths and the circumference of the shafts.

shows no peculiarity. The left ulna has a marked outward curvature in the lower portion of the shaft, whereas the corresponding radius is normal at that level. However, the left ulna shows some exostosis on the carpal surface, which gives it the appearance of having two styloid processes instead of one (see Pl. 29, B). The metacarpal bones show no abnormality and the flexor attachments and their fibrous sheaths seem to be normal.

THE SKULL

Like the rest of the skeleton, the skull shows a certain amount of fossilization, particularly the lower jaw. The vault shows no artificial deformation; its measure-

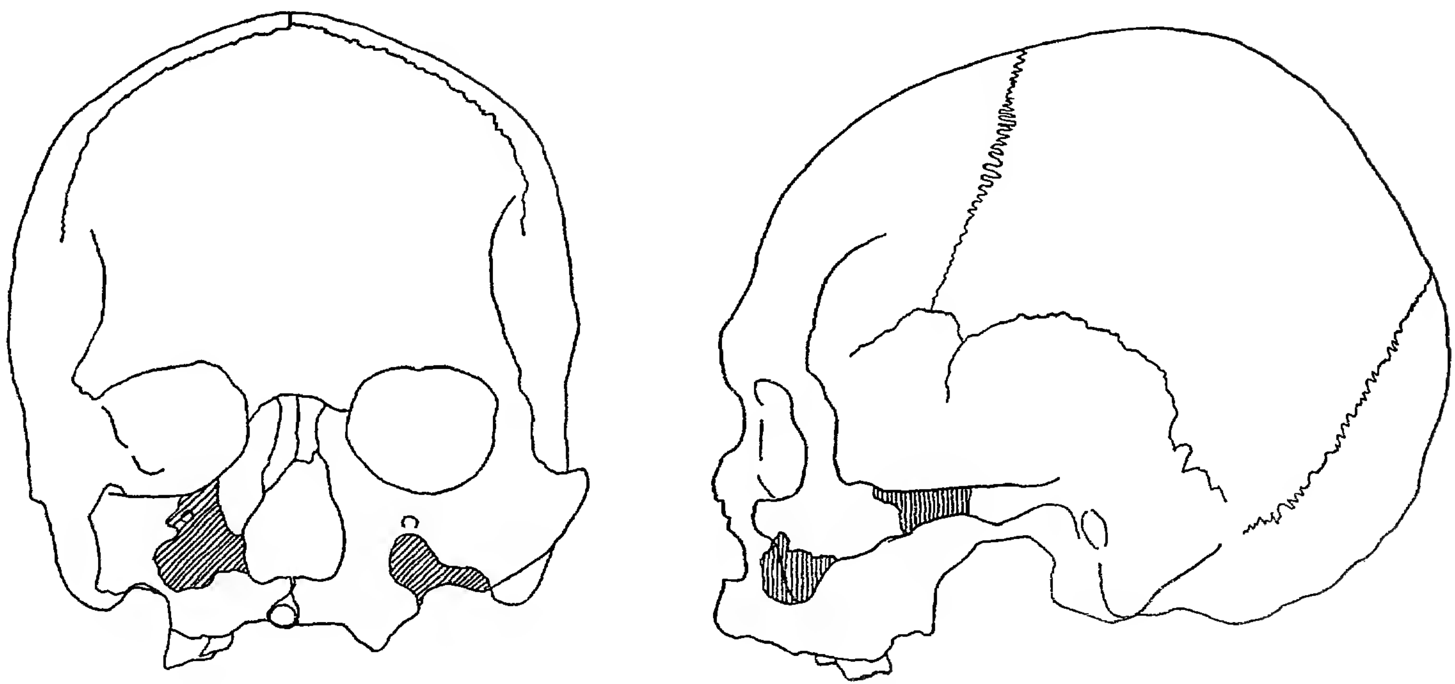

FIG. 20. FRONTALIS AND LATERALIS SINISTER NORMAS OF THE SKULL
The shaded sections indicate restored portions.

ments and observations may be considered accurate. However, that is not the case with the facial portion (Fig. 20). Although the restoration of the face is the result of several careful attempts, particularly the joining of the cranium and the facial portion, the measurements cannot be considered absolutely accurate. Like the measurements of the long bones, the skull measurements were carefully checked by Dr. Stewart. The comparisons below are made with observations on the American Indian collections examined in Mexico and in the U S National Museum.

The norma verticalis is ovoid and medium, that is, neither broad nor elongated The degree of roughness of the muscular attachments is also medium. The brow ridges are not very markedly developed, amounting rather to two thickenings on each medial half of the upper orbital edge, separated by a narrow depression at the glabella. The frontal bosses are not marked. The forehead is medium in width, height and slope. There are no vestiges of frontal crest. The sagittal elevation is medium on its middle third. The right parietal foramen is of normal dimensions, but the left one is very small. There are no supraorbital foramina.

The degree of temporal fullness is small. The mastoid processes are medium in size and the supramastoid crests are not very marked. The pterions are not perfectly visible because of suture closure and the fragmentary condition of the skull; they appear to have been H-shaped and rather narrow. The tympanic plates are very thin. On the right one we find a foramen, which is perhaps a recent breakage. The auditory meatuses are eliptic in shape and there are no vestiges of ear exostosis.

The occiput is moderately prominent. There is a torus of medium proportions, a depression above the inion and a slight natural flattening on the lambdoid region. The foramen magnum is large and broad. There are neither styloid processes nor pharyngeal fossa; and the glenoid fossae are free of exostosis.

Suture complication is, as a whole, moderate, with only a small wormian bone on the lambda, belonging to the sagittal suture.

The orbits are of medium size and rectangular in shape. The edges are dulled, as is generally the case in males. The slope of the transverse orbital diameters is very slight.

The malar bones are of medium size Both the lateral and anterior projections of the left one appear to be medium, but because this was one of the parts restored, we cannot be certain. The suborbital fossae are shallow. The portion of the zygomatic recovered suggests that it was of medium thickness.

The nasion depression is marked, as in so many American Indian specimens. The nasal spine, though broken, seems to have been medium in length and width, judging from the size of the root. The nasal bones are narrow, with concave outer edges and concave-convex profile. This profile is almost vertical from the nasion down as far as 8 mm; from then on the nasal bones are convex. The nasal sills are rather sharp.

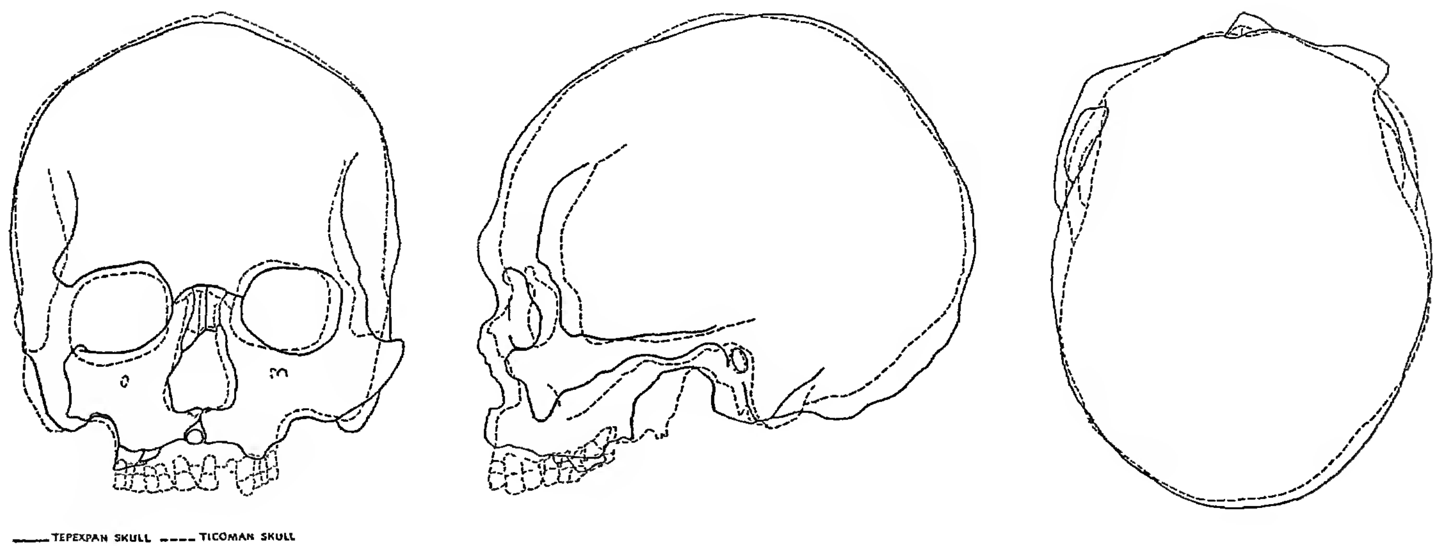

FIG. 21. COMPARISON OF FRONTAL, LATERALIS SINISTER AND VERTICALIS NORMAS
Tepexpan Skull and No. 99/9622 from Ticoman.

Facial prognathism is slight and there is nothing about the reconstructed parts to suggest that it was marked. Unfortunately, the alveolar prognathism is unknown because of the striking resorption of the upper alveolar edge. For this reason too it is impossible to guess what the palate shape originally was, but we can assume that it was eliptic and of medium height.

The lower jaw is medium in size. The chin is square-shaped and medium in projection. It does not indicate a very marked alveolar prognathism. The eversion of the gonial angles is moderate, a little more marked on the right one. The mental spines are large and the mylohyoid line is rather pronounced. The surfaces of the pterygoideus internus attachment are rather rough. There are no signs of lingual exostosis. The dentition of this specimen is discussed elsewhere (Appendix D).

TABLE 7. CRANIAL MEASUREMENTS

Glabello-occipito length	179 mm.	Bigonial breadth	104 mm.*
Max. breadth	143 "	Min. width ascending ramus, left	36 "
Basion-Bregma height	136 "	Mandibular angle	105° *
Left parietal thickness	4 "	Horizontal circum.	516 mm.
Min frontal diam.	99 "	Nasion-Opistion arc	380 "
Auricular height		Nasion-Bregma arc	129 "
a) at Bregma	119 "	Bregma-Lambda arc	122 "
b) at Vertex	126 "	Lambda-Opistion arc	129 "
c) at Apex	122 "	Transverse arc	313 "
Byzigomatic breadth	140 "*	Nasion-Opistion diam.	131 "
Basion-Nasion length	94 "	Nasion-Bregma diam.	115 "
Nasal height	49 "	Bregma-Lambda diam.	108 "
Nasal breadth	25 "	Lambda-Opistion diam	109 "
Left orbital height	34 "	Foramen Magnum length	37 "
Left orbital width	40 "	Foramen Magnum breadth	35 "
Right orbital height	35 "	Cranial capacity	1540 cc.
Interorbital breadth	24 "		
Symphysis height	33 "		

Three procedures were used to get the cranial capacity. The first one was the immersion of the endocast. Measuring the volume of water displaced three times gave practically the same results (1540 cc). Therefore, this procedure may be considered satisfactory. The second was the mustard-seed method which gave capacities of 1530 and 1520 cc. Finally, the Lee-Pearson formula was applied and an even lower figure was obtained. Since the endocast was carefully made and thus an accurate measure of the cranial capacity, only the results obtained by the immersion procedure will be considered.

The skull is mesocranic (index 79.89), although on the border of brachycrany. The height-length index (75.98) indicates hypsicrany or a high vault; by the height-breadth index (95.10) it is metriocranic. The cranial module (1526) is rather close to cranial capacity (1540 cc). The nasal index (51.02) indicates

chamaerrhyny, although it is very near from the mesorrhinic type. The orbits are rather high, as shown by the left orbital index (85 00) but it almost falls on the mesoconchic-hypsiconchic borderline. The fronto-parietal index (69.23) shows that

TABLE 8. CRANIAL INDICES

Length-Breadth	79.89	Cranial Module	15.26
Height-Length	75 98	Nasal	51.02
Height-Breadth	95 10	Left Orbital	85 00
Fronto-Parietal	69 23	Fronto-Gonial	95 19*
Auricular Height-Length a) 66.48 b) 70 39 c) 68 16			

* Approximate.

the minimum frontal breadth is somewhat broad relative to maximum vault breadth But the former seems to be very similar to bigonial breadth, which is approximate, as the fronto-gonial index (95.19) shows.

DISCUSSION

THE main problem posed by this find may be summarized in the following questions: Does the Tepexpan skeleton resemble pre-Columbian indigenous groups of Mexico? Do the remains differ from these groups, but resemble ancient groups of other parts of America? And, in either case, how should the inquiry be carried out?

Tepexpan Man belongs to a very ancient epoch, 11,000 years ago, based on present estimates, from which we have no comparative Mexican materials. We must discount the human remains found at El Peñon de los Baños whose dating is uncertain due to insufficient information concerning its discovery. Therefore, as a starting point it is necessary to take into account the earliest remains available, that is, those from the Archaic period of the Valley of Mexico. This period is believed to have begun a few centuries B.C. About that period Vaillant said: "We had isolated there three cultural groups designated by the terms Early, Middle and Late Zacatenco on the basis of figurines, pottery, and other artifacts."[7] During his field work Vaillant found a short series of burials from each "cultural group" mentioned and located at El Arbolillo, Zacatenco and Ticoman. Some of these skeletons are at the National Museum of Anthropology of Mexico and the rest at the American Museum of Natural History in New York. In respect to the burial data I am using Vaillant's reports on these three archeological sites.

Tepexpan Man was not surrounded by remains of a tomb or fossa. In this regard we read that at El Arbolillo "There were two chief methods of preparing the grave. Direct inhumation consisted of excavating a simple shaft and laying the body, usually wrapped in a mat. . . ."[8] and at Zacatenco "There was no formal preparation of the grave, like lining it with stones";[9] at Ticoman "The preparation of the grave was simple. Excavation by means of a digging-stick or other rude tools made soft ground essential. Hence, accumulations of debris were sought. . . . After the body had been laid away, the graves were filled up. When the ground was deep, the excavated dirt was thrown into the grave. . . . No markers seem to have indicated the presence of graves, nor could there have been any great horror of the dead once they were buried. We were constantly finding disturbed burials with the intruding sepulture lying in the midst of the dislocated bones of the preceding one."[10]

[7] G. C. Vaillant, *Excavations at Ticoman* (1931), 329.
[8] Vaillant, *Excavations at El Arbolillo* (1935), 182.
[9] Vaillant, *Excavations at Zacatenco* (1930), 188.
[10] Vaillant, *Excavations at Ticoman* (1931), 316-317.

On the other hand, Tepexpan Man was found unaccompanied by any association of pottery or implements. However, we know that at El Arbolillo eight of the burials had no mortuary offerings . . . five of these burials belong to the Early El Arbolillo I and the remaining to the El Arbolillo II. All of them are of adults and the total number of this kind was thirty-one. At Zacatenco nineteen burials were found on which it is to be read that "Funeral furniture was absent with the exception of an obsidian blade near skeleton No. 17 (Fig. 12), an association which may have been accidental."[11] With reference to Ticoman we find that "Sixty-one burials, some of which were disturbed, were found at Ticoman. . . . Of these sixty-one graves, eleven were disturbed. Thirty-three of the remaining fifty had mortuary furniture, and four of the disturbed skeletons likewise had objects associated with them. Thus the placing of objects in a grave was a standard custom. Obviously, no one would state positively that because no objects were found with a burial, there must have been an offering of perishable material, although such a possibility suggests itself."[12] That is, at Ticoman there were found at least seventeen skeletons without funeral furniture. The paragraph last transcribed might apply to any burial from any archeological period, as well as to the Tepexpan find. In short, although the presence of objects in the graves seems to have been the standard custom, there are several cases at each of these three sites which lacked them. Incomplete skeletons were also frequent as a result of ancient disturbances.

In regard to the position of the skeletons we have the following data: "To sum up, in Early El Arbolillo I direct burial in a flexed position seemed to be the rule, but in Late times the extended position, ordinarily in a slab tomb, was the usual mortuary method. In El Arbolillo II, direct burial employing both the flexed and extended positions seems to have been resumed, although a few tombs still were made."[13] At Zacatenco we find that "Where the ground was soft and relatively free from stones, the extended position was found, but in the stony upper slopes of the hill, we encountered more commonly a tightly flexed position."[14] With reference to Ticoman "The bodies, usually flexed or semi-flexed, were placed in the graves and were not oriented. . . ."[15] But the most striking fact, which I wish to emphasize, is the great variation of the flexed position Vaillant found, as shown in figures 7, 8 and 9 of *Excavations at El Arbolillo,* pages 173, 175, 177; Map 1 of *Excavations at Zacatenco,* page 189, and Maps I and II of *Excavations at Ticoman,* pages 422 and 425. Certainly, the position of many of these burials would lead one to misjudge them as individuals who died accidentally and were allowed to remain where they fell, particularly when they lacked of associative objects. The

[11] Vaillant, *op. cit.* (1930), 188.
[12] Vaillant, *op. cit.* (1931), 316.
[13] Vaillant, *op. cit.* (1935), 182.
[14] Vaillant, *op. cit.* (1930), 188.
[15] Vaillant, *op. cit.* (1931), 316.

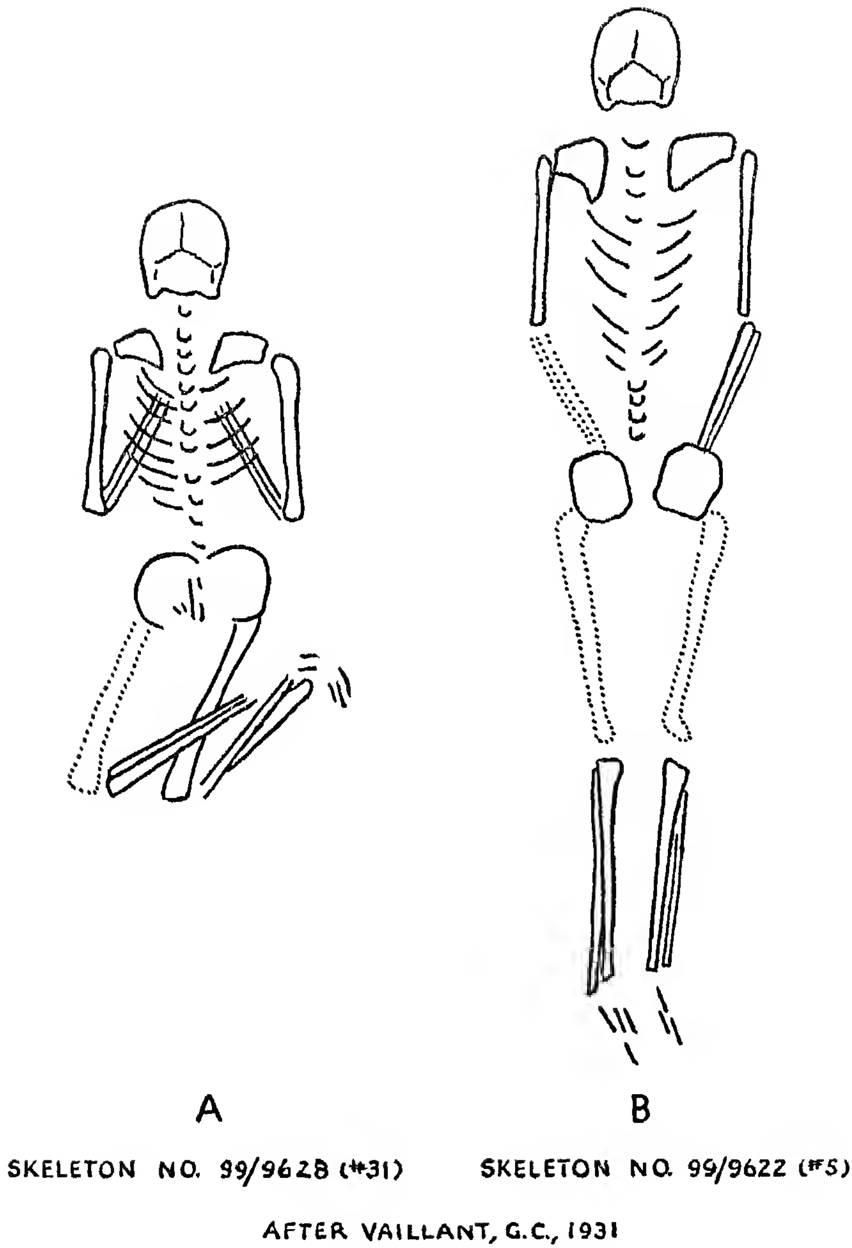

FIG. 22. POSITION OF BOTH SKELETONS FROM TICOMAN

Compare that of skeleton No. 99/9628, with the Tepexpan find of Fig. 17.

flexed and face-down position of Tepexpan Man is found in several cases as in burials No. 125 from Late Arbolillo I, Nos. 102 and 144 from El Arbolillo II, perhaps Nos. 1 and 11 from Zacatenco and Nos. 31 (see Fig 22), 38, 58 and 60 from Ticoman.

Now, we shall consider the skeletal material. From several subdivisions of El Arbolillo there were obtained 62 skeletons, from Zacatenco 19 and from Ticoman 61, of both sexes and all ages. Many are reported to be in "bad condition" by Vaillant and most of the skulls are deformed. Thus, we do not know exactly what were the osteological characteristics of the Archaic male population of the Valley of Mexico. However, for present comparative purposes such a knowledge does not seem absolutely necessary.

Tepexpan Man's stature is calculated to be about 170 cm. This is taller than the average pre-Columbian or modern Indian male population of Mexico. From the scanty skeletal material from El Arbolillo and Ticoman at Mexico City we have the following data for the adult male series:[16]

STATURE CALCULATED FROM MANOUVRIER'S TABLES
(based on femora)

	No. of cases	min.	average	max.
El Arbolillo	14	161.5	164.6	172.2
Ticoman	27	154.5	161.6	165 0
Tepexpan Man			166.6*	

* See Table 4

The procedure used to ascertain the stature from both series is that which I described on page 102. Tepexpan Man's stature, derived either from the femora (166 6) or the average (169.5) falls at least within the range of El Arbolillo small series. Moreover, the first figure, based on femora, does not differ a great deal from the maximum of the Ticoman series, as herein reported.

Through the kindness of Dr. H. L. Shapiro, Chairman of the Department of Anthropology of the American Museum of Natural History of New York, I had the opportunity to study the pre-Columbian collections of crania at that Museum. Among the Archaic series I found two undeformed specimens from Ticoman (catalogue numbers 99/9622 and 99/9628; field numbers 5 and 31 respectively), reported by Vaillant as follows:[17]

> 6.—Skeleton No. 31, probably male, middle age, fair condition, legs washed out; flexed prone, head west, face down. North of Trench B, Second Excavation, on surface. Indeterminate Period.

[16] Data supplied by Mrs. Johanna Faulhaber de Saenz of the National Museum of Anthropology of Mexico City.

[17] Vaillant, *op. cit.* (1931), 423.

15.—Skeleton No. 5, elderly adult, perhaps male; good condition, but partially eroded; extended prone, head west, face down. Trench C. Very Late Period.

The periods Vaillant refers to are the subdivisions of Late Zacatenco (Ticoman I, II, III). Unfortunately the corresponding skeletons are missing and skull No. 99/9628 shows plagiocephaly. No. 99/9622 shows tooth mutilation on both upper central incisors and the lower left one, Type B-1, according to the new classification table.[18] As these two skulls were the only ones available it seemed to me interesting to compare their measurements and morphological characteristics with those of the Tepexpan skull. The Ticoman specimens are adult, male and very well preserved. Tables 9 and 10 show a comparison.

I wish to point out that when I found these Ticoman specimens I was struck by certain resemblance to that from Tepexpan (Pls. 36 and 37). The Archaic specimens dug out by Vaillant, which are now at the National Museum of Anthropology of Mexico, are without exception deformed. Therefore, this was the first opportunity to make a comparison with normal skulls from that period. Tables 9 and 10 suggest a close morphological similarity. Fig. 21 is a comparison of frontal, lateralis sinister and verticalis normas of Tepexpan skull and No 99/9622 from Ticoman and, Fig. 22 shows the position of both skeletons from Ticoman.

As can be seen, the traits of some of these Archaic burials show an amazing similarity to those of the Tepexpan find, while the position of skeleton number 31 is practically identical. Nor is the absence of associations uncommon among those burials of Ticoman. We did not find any evidence that the Tepexpan skeleton had been wrapped in a mat, although as a result of the wetness of the soil such evidence may have been destroyed. Concerning the degree of fossilization of the Tepexpan remains, it is well to note that this is of little significance for at the U.S. National Museum there are specimens from relatively recent periods whose fossilization is as great or even greater. Nevertheless, among the specimens of the Archaic period no fossilization has been encountered.

Another fact which is not to be overlooked is that the El Arbolillo, Zacatenco and Ticoman sites are located within the Valley of Mexico, and other Archaic burials were found only two kilometers from the Tepexpan site.

Now, what is the significance of this morphological similarity? Of course I do not suggest that the Ticoman specimens are representative of the Archaic population of the Valley of Mexico. Such an inference, based on only two specimens would hardly be justified. Nor can we state that we know Tepexpan people of 11,000 years ago on the basis of the single skeleton found last year and de-

[18] J. Romero, *Tooth Mutilation and Cranial Deformity at Guasave, Sin., Mexico*. John Simon Guggenheim Memorial Fellow, 1947-1948. Unpublished.

TABLE 9. TEPEXPAN AND TICOMAN SKULLS
Measurements

	Tepexpan skull	Ticoman No. 99/9622	Ticoman No. 99/9628
Glabello-occipital length	179 mm.	173 mm.	174 mm.
Maximum breadth	143 "	136 "	140 "
Basion-Bregma height	136 "	142 "	135 "
Thickness of left parietal	4 "	5 "	5 "
Minimum frontal diameter	99 "	95 "	93 "
Bizygomatic breadth	140 "*	134 "	136 "
Basion-Nasion length	94 "	100 "	100 "
Nasal height	49 "	47 "	50 "
Nasal breadth	25 "	23 "	26 "
Orbital height, left	34 "	33 "	33 "
Orbital width, left	40 "	39 "	41 "
Orbital height, right	35 "	33 "	32 "
Interorbital width	24 "	23 "	23 "
Height of Symphysis	33 "	35 "	36 "
Bigonial width	104 "*	104 "	93 "
Min. width ascending ramus, left	36 "	38 "	36 "
Horizontal circumference	516 "	495 "	512 "
Nasion-Opistion arc	380 "	360 "	361 "
Nasion-Bregma arc	129 "	125 "	131 "
Bregma-Lambda arc	122 "	114 "	114 "
Lambda-Opistion arc	129 "	121 "	116 "
Transverse arc	313 "	316 "	314 "
Nasion-Opistion diameter	131 "	132 "	136 "
Nasion-Bregma diameter	115 "	110 "	114 "
Bregma-Lambda diameter	108 "	103 "	103 "
Lambda-Opistion diameter	109 "	102 "	101 "
Foramen Magnum length	37 "	34 "	37 "
Foramen Magnum breadth	35 "	30 "	28 "

Indices

Length-Breadth	79.89	78.61	80.46
Height-Length	75.98	82.08	77.59
Height-Breadth	95.10	104.41	96 43
Fronto-Parietal	69.23	69.85	66.43
Nasal	51.02	48 94	52.00
Left Orbital	85 00	84 62	80.49
Fronto-Gonial	95.19*	91.35	100.00
Cranial Module	1526	1503	1496

* Approximate.

scribed in the present report. We do not know what the characteristic morphological traits of such a population were, statistically speaking, but within the range of the three Archaic cultural levels mentioned, the Ticoman and El Arbolillo speci-

TABLE 10. TEPEXPAN AND TICOMAN SKULLS
Morphological Observations

Observation:	Tepexpan skull	Ticoman No. 99/9622	Ticoman No. 99/9628
Form	ovoid, medium in width	pentagonoid, medium in width	ovoid, medium in width, assymetrical
Brow Ridges form	thickenings on each medial half	thickenings on each medial half	thickenings on each medial half
Brow Ridges size	medium	small	medium
Forehead width	medium	medium	medium
Forehead height	medium	high	low
Forehead slope	medium	medium	medium
Frontal bosses	small	small	medium
Mediam crest	none	none	none
Sagittal elevation	medium at the middle third	large at the anterior third	medium at the anterior third
Temporal fullness	small	medium	small
Mastoid size	medium	large	medium, right, small, left
Occiput	moderately prominent	prominent	moderately prominent
Occipital torus form	ridge	none	none
Occipital torus size	medium		
Tympanic plate	very thin, probably perforated at right	medium, perforated at both sides	medium
Auditory meatus	ellipse	ellipse	oval
Ear exostosis	none	none	none
Orbits shape	oblong	oblong	oblong
Orbits inclination	small	small	medium
Suborbital fossa	slight	slight	slight
Ant. malar projection	medium	medium	medium
Lat. malar projection	medium	medium	medium
Zygomatic processes	medium	medium	thick
Nasion depression	pronounced	medium	medium
Nasal bones	narrow	medium	broad
Nasal spine	medium?	small	medium
Facial prognathism	slight	slight	pronounced
Alveolar prognathism		medium	slight
Palate shape	probably elliptical	elliptical	elliptical
Palate height	probably medium	medium	medium
Mandible size	medium	medium	medium
Chin form	square	square	square
Chin projection	medium	medium	medium
Alveolar prognathism	medium	medium	medium
Gonial angles eversion	medium	medium	pronounced
Mental spines	large	large	small
Mylohyoid line	pronounced	medium	slight
Lingual exostosis	none	none	none

mens occupy a position or point into which Tepexpan Man approximately falls. The morphological similarities between Tepexpan and Archaic specimens must be understood not in terms of populations but of individuals. It is true that two very similar individuals can belong to different populations in time and space, but in this particular anthropological problem it is important to remember that the affinities exist between specimens from sites in the same geographic region, and that El Arbolillo, Zacatenco and Ticoman belong to the most ancient cultural epoch so far established. The Tepexpan cranial type might have lasted through pre-Columbian times and until the Conquest, and perhaps its distribution was very broad, but this is a question which is not the specific purpose of the present report.

I must confess that I do not know how the evidence presented can be rightly interpreted. It cannot be assumed that the Tepexpan find is an Archaic burial because of its degree of fossilization nor because it was found in a formerly swampy bed below the caliche soil formed approximately 10,000 years ago. Such an age for the Archaic period would be unacceptable to any archeologist, although cultural traits, such as the position of the body and the absence of associations customary during the full Archaic period, may very well have appeared much earlier.

On the other hand, the position of the skeleton and the absence of mortuary furniture, do not permit one to state definitely that Tepexpan Man died accidentally, although it remains as a possibility. The skeletal remains seem to indicate that he was not different from certain ancient Archaic individuals who once inhabited the Valley of Mexico.

In the present state of our knowledge it would appear that the bearers of the Archaic culture were settled in the Valley of Mexico much earlier than we had suspected. Future discoveries should make it possible to establish whether the Tepexpan find is a burial of Archaic type as later found at El Arbolillo, Zacatenco and Ticoman.

Finally, using the splendid craniological collections in the Division of Physical Anthropology in the U.S. National Museum, I made interesting comparisons with the series from Indian Knoll, Green River, Ohio County (Kentucky); Santa Barbara County (California) and a series of Algonquin crania; and the Lansing (Kansas), Vero (Florida) and Goat Cave, Valverde County (Texas) crania. For the same purpose I used a collection of photographs of crania mostly from Pickwick Basin, Alabama. Some of these series are from the pre-ceramic period in the United States, a period we hardly know in Mexico. Some of these specimens also show striking similarities to the Tepexpan skull, as in Nos. 242.154, 242.149 and 242.160 from Santa Barbara Co. California, to cite only a few examples. I will omit these considerations in view of Dr. Stewart's report in another section of the present volume.

SUMMARY

The fragmentary nature of the Tepexpan find necessitated the repair of most of the bones. This involved repeated attempts before satisfactory results were obtained After restoration, the skeleton was found to be that of a male, about 170 cm tall, of rather slender build, and between 55 and 65 years old.

For comparative purposes data and specimens from the Archaic period of the Valley of Mexico have been used. Analyzing the circumstances surrounding the Archaic burials found at El Arbolillo, Zacatenco and Ticoman, those of Tepexpan find do not seem to be different from some of them. The similarities are mainly the absence of mortuary furniture and the position of the skeleton.

The survey of the available skeletal material from the above mentioned sites reveals that the stature of Tepexpan Man as well as morphological traits of the skull are also present among some of the individuals of the Archaic period.

The characteristics of the Archaic burials suggest the possibility that the Tepexpan find is a burial, although this is not at all certain. From the morphological resemblance the only conclusion to be drawn is that people who achieved the known Archaic cultural level during the last centuries B.C. probably inhabited the Valley of Mexico several thousand years earlier, as it is suggested by the age of 11,000 years assigned to the Tepexpan find.

APPENDICES A-F

APPENDIX A

INVENTORY OF THE HUMAN BONES FOUND AT TEPEXPAN

Cranium:

Vault complete.

Base fragmented but almost complete: three fragments of sphenoid bone; left petrous portion; basilar part including the occipital condyles.

Face:

Frontal processes of maxilla.

Nasal bones.

Fragment of right and left maxilla.

Fragment of left malar.

Alveolar margin of maxilla.

Palate.

Fragment of left orbital plate.

Mandible:

Lacking condyles and posterior portion of right ascending ramus. Four unidentified small fragments.

Vertebrae:

Nine fragments, among which is an almost complete epistropheus.

Ribs:

Five fragments, seemingly belonging to different ribs.

Pelvis:

Small fragment of innominate.

Small fragment of sacrum.

Upper Extremities:

Middle portion of right and left clavicles; right acromial extremity and a small fragment of right scapula.

Shafts of right and left humeri and a fragment of the head of one of the humeri.

Right and left ulnae with the proximal end present only in the right ulna.

Right radius almost complete and the left one lacking proximal end.

Hand bones:

Ten metacarpals.

1st., 2nd., 4th. and 5th right first phalanges.

3rd. left first phalanx.

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Right radius almost complete and the left one lacking proximal end.

Hand bones:

Ten metacarpals.

1st., 2nd., 4th. and 5th. right first phalanges.

3rd. left first phalanx.

3rd., 4th., 5th. right second phalanges.
4th , and 5th. left second phalanges.
1st., 2nd., 5th. right third phalanges.
1st. left third phalanx.

Lower extremities:

Shafts of right and left femora and the left distal extremity separate.
Three fragments of the distal end of right femur.
Right and left patellae.
Right and left tibial shafts.
Nine fragments of the proximal ends of the tibiae.
Fragment of distal extremity of the tibia.
Three fragments of fibular shafts.

Foot bones:

Right and left talus.
Right cuboid.
Left 2nd. cuneiform.
1st. and 5th. metatarsal bones.
Left 1st., 2nd. and 4th. first phalanges.
Eight unidentified fragments.

Unidentified fragments when the present inventory was made:

88 small fragments.
40 larger fragments.

APPENDIX B

PRELIMINARY REPORT ON THE ANATOMICAL CHARACTER OF THE HUMAN SKELETON FROM TEPEXPAN

THE general character of the bones indicates that the individual belongs to the recent human type (Homo sapiens).

Although the skull does not reveal any special primitive feature characteristic of early hominids (the total calvarial height being about 140 mm, rather noteworthy considering the size of the skull) there are some structural peculiarities which are more primitive than those usually found in modern human skulls. The frontal and occipital superstructures are well developed. Both come very close to real torus formations. The frontal superstructure consists of a distinct eyebrow ridge on both sides. The ridge extends to the glabella region and turns downwards to the frontonasal suture forming a well-marked supranasal torus such as occurs in the Australian bushman today and in other "primitive races." The supraorbital ridges proper show an advanced stage of deterioration, but the original character of the ridge is easily recognizable. The occipital bone exhibits a typical occipital torus which resembles even the condition found in Neanderthal skulls. Similar primitive features are recognizable at the nuchal planum, the mastoid and the parietal region (temporal line).

These primitive features are not restricted to the braincase. They occur also in the extremity bones in which they appear under the form of pronounced muscular tuberosities (deltoid tuberosity of the humerus, crista interossea and crista musculi pronator quadratus of the radius).

The facial skeleton does not show any special primitive features. There is neither a general nor an alveolar prognathism. The teeth, so far as they are preserved, are those of modern man.

Regarding special racial characteristics, the present condition of the facial parts does not permit a definite diagnosis. The nasal bones are "pinched," a peculiarity frequently encountered in certain mongoloid types (Eskimo). The cheekbone, on the other hand, is small and does not project to a marked extent either forwards or sidewards. The crowns of the upper incisors are not preserved, hence it is impossible to recognize whether these teeth were shovel-shaped (mongolian characteristic) or not.

The braincase has a particular form: the vertex region is pronouncedly domed without showing any indication of artificial deformation. This shape may help to determine the special group to which the skull must be attributed.

None of the bones is very robust; on the contrary they rather appear to be of a generally fine structure. Although this suggests female sex, the strongly developed muscular tuberosities prove that the individual was a male.

The tentative estimation of the cranial capacity is from 1,350 to 1,450 cc.

Taking all morphological facts into consideration, as far as it is possible to do so at this moment, it can be stated that none of them contradicts the possibility that the Tepexpan skeleton is that of an individual who lived at the end of the Pleistocene period. All the skeletons of Upper Paleolithic man known from Europe, Asia and Africa, already show the features characteristic of recent mankind. In most cases really primitive characteristics are completely missing Wherever features were found recalling primitive conditions, they show a more or less pronounced degree of disintegration, as is the case with Tepexpan man.

On account of the inconclusiveness of the anatomical character of the skeleton, its identification as one of Pleistocene age cannot be based on anatomical evidence alone. An important criterion in this respect is the degree of fossilization of the bones. All the bones of the Tepexpan skeleton are mineralized but the degree of mineralization varies; the lower jaw, for example, shows a higher degree than the brain case and the remaining facial bones. In the extremity bones, the mineralization led to a complete metamorphosis of the internal structure of the compacta such as is typical of human bones from the Middle Pleistocene of China and Java.

Therefore, I arrive at the following conclusion: If the stratigraphy of the Tepexpan skeleton proves the Pleistocene ages, the anatomical character and the degree of its mineralization lend strong support to this assumption.

FRANZ WEIDENREICH

Mexico City, March 30, 1947.

APPENDIX C

INITIAL IMPRESSIONS REGARDING THE TEPEXPAN SKELETON

ON first viewing the human skeletal remains from Tepexpan I was struck by the fact that here was a skull of the type that Hrdlička was wont to call "Algonkin"; that is, moderately long and high headed with a gracile build. It recalled, moreover, two skulls of this type now in the U. S. National Museum which also have claims to antiquity. One of these was dredged from the old deposits of the Missouri River; the other is the Lansing Skull, likewise from our Midwest. These two speciments are still exhibited with a modern "Algonkin" skull between them to show the identity of the type. The originator of this exhibit intended to show that the modern form of these skulls disproved their antiquity. Now, however, the geological dating of the Tepexpan remains, together with other recent evidence relating to the antiquity of man in America, all indicate that this skull type, even though surviving today, has been on the continent for a long time. As Dixon so clearly showed in his *Racial History of Man,* the peripheral distribution of this type today further bears out this conclusion.

As for the anatomical details of the Tepexpan specimen, I am in agreement with the observations carefully set forth by Dr. Weidenreich in his preliminary report. I would add only that this early American was past middle life, and in this connection would call attention to the advanced suture closure, extensive dental destruction and marked arthritic manifestations in the cervical vertebrae. Earlier in his life this individual had sustained a fracture of the lower end of the right ulna, but this had healed without notable shortening of the bone and without much deformity.

Because of his unmatched experience in the study of the truly ancient human skeletal remains of the Old World, Dr. Weidenreich naturally was impressed by the lack of primitive features in this New World specimen. On the other hand, my different experience—mainly with American Indian material—leads me to be impressed with the predominantly Indian character of the specimen. I am certain that this specimen, if not mineralized, could not be distinguished from the remains of recent Indians recovered in various places in the eastern United States, and probably also elsewhere in the hemisphere.

The state of mineralization is impressive, as Dr. Weidenreich has pointed out. However, in view of the fact that the specimen was found in the wet muck of an old lake bed, this may not be too significant. Skulls that I have seen which were found under similar conditions in Florida (Belle Glade), California (Sacramento

Valley), and Argentina (Rio Negro), show the same discoloration and heaviness and yet are not of great age. These mucks, perhaps due to the presence of certain chemicals, seem to favor the indefinite preservation of bone. Thus, the mineralization of the Tepexpan specimen, like the anatomical characters, is not in itself a certain criterion of antiquity.

The presence of other parts of the skeleton besides the skull promises to give some information on body proportion, and especially stature. This will be important because heretofore there has been no evidence on this subject. Unfortunately, at the time of my examination the work at the site was uncompleted, and there was no way of knowing whether the parts indicated by the fresh breaks on some of the long bones would be recovered. My impression was, however, that this individual could not have been very tall.

On the basis of the above reasoning I would conclude that there is nothing about the Tepexpan skeleton inconsistent with the age attributed to it by the geologists. Also, because of the seeming indubitable evidence of its stratigraphic position and faunal association, it is most important that it be described in detail both anatomically and anthropologically In the latter connection the skeletal remains of the American Indians should be taken fully into consideration.

T. D. STEWART

Mexico City, April 10, 1947.

APPENDIX D

THE JAWS OF THE TEPEXPAN SKELETON

THE jaws of the Tepexpan skeleton present certain peculiarities and the purpose of this report is to give a description and interpretation thereof. We shall divide our study into two parts: the first part will refer to the description, and the second to the discussion of the radiographs taken for this purpose.

DESCRIPTION

Upper Jaw. The upper jaw still retains three teeth, as follows: a supernumerary tooth, the first right molar and the second right molar. Only one of the three roots, the palatine, of the first molar is preserved; the two vestibular roots having been lost through an infection which destroyed the alveolar walls. In the second molar, the enamel is noted only in the vestibular part, since the occlusal surface, as well as the palatine surface, shows the dentin worn down to near the dental pulp (Pl. 35, c).

Lower Jaw. Ten teeth are found in the lower jaw: the four incisors, the two cuspids and the first and second premolars, both the right and left.

An intense abrasion is noted on all the teeth, but this is most marked on the lingual surface of the four incisors and on the occlusal surface of the second left premolar where the abrasion extends as far as the pulp chamber although without exposing it entirely.

Abrasion. The most outstanding characteristic presented by the Tepexpan jaws is the intense wear of the occlusal surfaces of the teeth.

The dental abrasion leads one to think that the subject under study worked hard at mastication, perhaps due to the diet of the period in which he lived. Probably a diet consisting of dry roots, wild herbs, raw or semi-raw meats, and dry cereals mixed with sand or the powder from the stones which served as mortars, caused the dental enamel to be worn down by the act of mastication.

The abrasions extended not only to the dentin but even to the pulp chamber, causing pulp necrosis and consequently an alveolar-dental abscess. This fact may be substantiated by the first upper right molar where the abrasion reached the point of separating the three roots of the molar, leaving the palatine root with its respective alveolar-dental abscess, and the peridental infection had previously destroyed the alveolar walls of the two vestibular roots. This same process is probably what destroyed the greater part of the missing teeth. Therefore the loss

of the teeth is not due to dental caries, so common in other individuals, but to the abrasion which is so notable on the existing teeth.

RADIOGRAPHIC EXAMINATION

Upper Jaw. In the forepart, which corresponds to the center right incisor, we find a certain peculiarity, the radiographic interpretation of which has presented no few difficulties. It appears that there exists in the anterior palatine foramen a supernumerary tooth, in an inverted position, that is with the crown toward the roof of the mouth and the root toward the alveolar crest (Pl. 35, B). The apical region of the root is worn and presents a certain hypercementosis as the result of the trauma produced by constant contact with the lingual surface of the lower teeth. It is probable that the supernumerary tooth may have moved down only after the loss of the incisor teeth.

We also find a root corresponding to the first upper right molar. (Pl. 35, C). It is the palatine root and shows an alveolar abscess. Also, in the zone corresponding to the vestibular roots there is noted the same destruction which, perhaps because of an infection, injured the pulp, also producing abscesses in the two roots. The second right molar is normal, with the exception of the abrasion which comes very close to the pulp chamber (Pl. 35, C).

Lower Jaw. A slight apical root reabsorption of the four incisors (Pl. 35, B) is noted in the lower jaw, this being more marked in the two center ones. The etiology of such reabsorption is not well understood, but in the present case it appears that, because of such intense wearing of the lingual surfaces of the teeth which we have mentioned, the reabsorption is due to a trauma produced by the upper teeth In the radiograph the wearing down of the enamel of all the existing teeth is also observed. This wear extends even to the dentin but in the second left premolar the abrasion reaches the pulp chamber which is still protected by a very thin layer of calcified dentin (Pl. 35, D).

As a result of the foregoing, we may infer that the loss of the teeth took place at different periods of the life of the individual, which is confirmed by the fact that in the upper jaw the region corresponding to the right premolars, as well as that belonging to the second left molar, is more calcified than the other zones of the same jaw. The region of the lower jaw which corresponds to the molars of both sides is entirely ossified, which likewise shows that the individual lost the mentioned teeth long before his death.

The alveolus of the teeth of the lower jaw are normal, which shows that there was no infectious process caused by pyorrhea which with time expels the teeth from their alveolus because of the alveolar atrophy. Loss of the other teeth is therefore due to abrasion.

The degree of abrasion, and the density of the bone tissue observed in the jaws

as well as in the radiographs, leads us to believe that this was a person of advanced age.

SUMMARY

1. No dental caries are observed in the jaws of the Tepexan skeleton.
2. The radiographic examination indicates that there was no infection caused by pyorrhea.
3. Intense dental abrasion shows on all the teeth.
4. The abrasion produced pulpal injuries and consequently alveolar abscesses.
5. The dental abrasion is due to the diet of the period.
6. The remains appear to be those of a person of advanced age.

SAMUEL FASTLICHT

Mexico City, June, 1947.

APPENDIX E

THE TEPEXPAN ENDOCRANIAL CAST

THE endocranial cast of Tepexpan Man is quite large, indicating a brain of above average size. The measurements in centimeters are: length, right side, 17.2; left, 17.0; breadth, 13.5. The length-breadth index is thus 78.5. The height measured above the lateral horizontal connecting the frontal and occipital poles is 8.0 cm.

The ridges representing the transverse sinuses of the two sides are symmetrically placed, a condition less frequently occurring in casts of modern man.

Very striking is the dorsal bulge at the parietal vertex. This is not the result of a postmortem excavation of the inner wall of the skull, as is evident from the continuation of the markings of the meningeal vessels over this area. The anterior part of this dorsal bulge begins with an elevation corresponding to a postbregmatic Pacchionin body. On the right side this is followed by a second protuberance. Posterior to the dorsal parietal bulge, the surface of the cast descends more sharply than does the corresponding external surface of the skull, thus emphasizing the dorsal expansion on the cast.

It would be erroneous to conclude that the brain, though undoubtedly above average height, had a dorsal parietal expansion corresponding to this dorsal bulge on the cast. The abrupt dorsal elevation, due mainly to the large Pacchionian bodies, and its extension over a wider area, is possibly the result of some abnormality in the dural sac or its contents. The brain had probably less height in this region than the dorsal surface of the cast would suggest. Evidence of this is seen in the more even dorsal contour of the external surface of the skull, which does not show such a pronounced bulge, though the parietal vertex is high.

The impressions on the surface of the cast are much more marked on the left side than on the right. Especially prominent on the parietal vault, is an ascending, sinuous elevation directed toward the postbregmatic Pacchionian body. The elevation decreases as it ascends on the vault, and its course is partly interrupted by slight shallow depressions, on which run the markings of the branches from the well-developed bregmatic meningeal vessel. The shallow transversing grooves give the sinuous elevation the appearance of a series of boss-like elevations decreasing in size dorsally. Of considerable interest is the fact that this expansion on the endocast is reflected in a corresponding expansion on the external surface of the skull, which is much more pronounced on the left side than on the right.

The unevenness of the surface of the cast in this region suggests at first a good representation of the fissures of the brain Although the course of the fissures

may partly coincide with the depressions on which run the meningeal vessels, it is improbable that the depressions represent the fissures. The furrows are not sharply defined, and do not show much continuity.

The region of the anterior temporal operculum is deficient, but the lower border of the orbital cap for its greater part is intact, so that one can infer the presence of a Sylvian notch. The Sylvian fissure is not represented on the left side, except possibly its caudal extremity.

The frontal region has some deep grooves, especially the paramedian furrows representing the superior frontal sulcus. The frontomarginal and middle frontal furrows can also be identified, but the inferior frontal sulcus is represented only by disconnected pits, so that nothing can be concluded concerning its form and extent.

The fissural markings on the temporal region are widely-spaced, short, disconnected furrows representing the superior and midtemporal sulci. On the occipital region are lateral calcarine furrows and the depression incising the medial border probably represents the retrocalcarine.

On the right side of the cast there is a defect in the anterior Sylvian area, but the region is sufficiently intact to indicate the presence of a Sylvian notch The area caudal to the deficient part is depressed and represents the anterior part of the Sylvian fissure. Its caudal ascending extremity is also represented. A straight, deep furrow represents the midtemporal sulcus, but the superior temporal sulcus is not represented. No postparietal furrows are identifiable on either side of the cast.

The impressions on the frontal region of the right side do not extend so far caudally as on the left. The chief furrows of this region can be recognized.

There is a long, shallow and slightly curved depression on the occipital surface of the right side. It appears to be an effect of an expansion along the border of the lambdoid suture, and not due to the presence of a lunate sulcus.

There is nothing in the size or form of the endocast or in the fissural impressions as far as they can be identified, to indicate anything of a primitive type of brain.

C. J. CONNOLLY

APPENDIX E

THE TEPEXPAN ENDOCRANIAL CAST

THE endocranial cast of Tepexpan Man is quite large, indicating a brain of above average size. The measurements in centimeters are: length, right side, 17.2; left, 17.0; breadth, 13.5. The length-breadth index is thus 78.5. The height measured above the lateral horizontal connecting the frontal and occipital poles is 8.0 cm.

The ridges representing the transverse sinuses of the two sides are symmetrically placed, a condition less frequently occurring in casts of modern man.

Very striking is the dorsal bulge at the parietal vertex. This is not the result of a postmortem excavation of the inner wall of the skull, as is evident from the continuation of the markings of the meningeal vessels over this area. The anterior part of this dorsal bulge begins with an elevation corresponding to a postbregmatic Pacchionin body. On the right side this is followed by a second protuberance. Posterior to the dorsal parietal bulge, the surface of the cast descends more sharply than does the corresponding external surface of the skull, thus emphasizing the dorsal expansion on the cast.

It would be erroneous to conclude that the brain, though undoubtedly above average height, had a dorsal parietal expansion corresponding to this dorsal bulge on the cast. The abrupt dorsal elevation, due mainly to the large Pacchionian bodies, and its extension over a wider area, is possibly the result of some abnormality in the dural sac or its contents. The brain had probably less height in this region than the dorsal surface of the cast would suggest. Evidence of this is seen in the more even dorsal contour of the external surface of the skull, which does not show such a pronounced bulge, though the parietal vertex is high.

The impressions on the surface of the cast are much more marked on the left side than on the right. Especially prominent on the parietal vault, is an ascending, sinuous elevation directed toward the postbregmatic Pacchionian body. The elevation decreases as it ascends on the vault, and its course is partly interrupted by slight shallow depressions, on which run the markings of the branches from the well-developed bregmatic meningeal vessel. The shallow transversing grooves give the sinuous elevation the appearance of a series of boss-like elevations decreasing in size dorsally. Of considerable interest is the fact that this expansion on the endocast is reflected in a corresponding expansion on the external surface of the skull, which is much more pronounced on the left side than on the right.

The unevenness of the surface of the cast in this region suggests at first a good representation of the fissures of the brain. Although the course of the fissures

may partly coincide with the depressions on which run the meningeal vessels, it is improbable that the depressions represent the fissures. The furrows are not sharply defined, and do not show much continuity.

The region of the anterior temporal operculum is deficient, but the lower border of the orbital cap for its greater part is intact, so that one can infer the presence of a Sylvian notch. The Sylvian fissure is not represented on the left side, except possibly its caudal extremity.

The frontal region has some deep grooves, especially the paramedian furrows representing the superior frontal sulcus. The frontomarginal and middle frontal furrows can also be identified, but the inferior frontal sulcus is represented only by disconnected pits, so that nothing can be concluded concerning its form and extent.

The fissural markings on the temporal region are widely-spaced, short, disconnected furrows representing the superior and midtemporal sulci. On the occipital region are lateral calcarine furrows and the depression incising the medial border probably represents the retrocalcarine.

On the right side of the cast there is a defect in the anterior Sylvian area, but the region is sufficiently intact to indicate the presence of a Sylvian notch. The area caudal to the deficient part is depressed and represents the anterior part of the Sylvian fissure. Its caudal ascending extremity is also represented. A straight, deep furrow represents the midtemporal sulcus, but the superior temporal sulcus is not represented. No postparietal furrows are identifiable on either side of the cast.

The impressions on the frontal region of the right side do not extend so far caudally as on the left. The chief furrows of this region can be recognized.

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There is nothing in the size or form of the endocast or in the fissural impressions as far as they can be identified, to indicate anything of a primitive type of brain.

C. J. CONNOLLY

APPENDIX F

PRELIMINARY TESTS FOR PRESENCE OF BLOOD GROUP SUBSTANCE IN TEPEXPAN MAN

AT the suggestion of Dr. Javier Romero preliminary examinations for the presence of blood group substances in the skeleton of Tepexpan Man were performed. Dr. William C. Boyd provided the sera, the facilities of his laboratory at Boston University School of Medicine, and supervision of the experiments.

The method employed was that of the absorption technique similar to the method used by earlier workers for determination of blood stains on cloth. This method was employed with excellent results by Dr. P. B. Candela in testing the skeletons of Aleut mummies.[1] These tests involve the application of serum of known strength to a specimen of pulverized bone. If the group substance which determines the blood type is present in the specimen of bone, the antibodies of the serum are wholly or partially absorbed and the strength of the serum is thereby reduced. After a suitable period of incubation the supernatant serum is drawn off the specimen and tested against red cells of the appropriate group. Failure to agglutinate these cells is presumptive evidence that agglutinins were removed from the serum and therefore that the group substance was present in the skeleton tested.

TEST MATERIAL

The most suitable bone for blood grouping tests is the cancellous tissue such as that found in the heads of long bones or in the bodies of vertebrae. Ordinarily this is best removed with a bone curet. The fragments of the Tepexpan skeleton submitted to me were small and were consequently placed directly in a mortar and pulverized This bone was then placed in airtight bottles in order that there might be as little chance as possible of deterioration of the absorptive power of the tissue.

SERA

One anti-A and one anti-B serum were selected for use in these tests. They were first tested on known blood stains on cloth and found to give uniform and accurate results in a series of tests.

These sera were titered by testing successively doubled dilutions, e.g., 1:3,

[1] P. B. Candela, *Blood-group Determination upon the Bones of Thirty Aleutian Mummies* (American Journal of Physical Anthropology, Vol. 24, No. 3, 1939), 361-383.

1:6, 1:12, 1:24, 1:48, 1:96. In the event the 1:96 dilution, for example, gave a $\pm$ reaction when tested with red cells and the 1:192 gave no reaction, the 1:96 was taken as the end point. Counting back three dilutions to 1:12 gave the dilution to be applied to the bone specimen.

Titration was performed in the following manner: 1 cc of the serum was diluted in successively doubled dilutions by adding equal amounts of isotonic 0.9% NaCl solution. These amounts were measured, as were all, with a 1 cc tuberculin syringe, using a twenty gauge needle. These dilutions were made in Wassermann tubes (13 x 100 mm). From each dilution 0.05 cc was drawn and placed in a blood grouping tube (10 x 75 mm). To each of these was added 0.05 cc of 1 per cent cell suspension. These were then placed in a rack and shaken ten times every four minutes for thirty-two minutes. Readings of the agglutination were made following this, using the low power of the microscope. Cell suspensions were accurately made up and the test cells were always drawn from the same person. Titration of sera was always performed immediately prior to the immersion of the specimen.

IMMERSION OF BONE SPECIMEN

A small amount of pulverized tissue was used for each test, viz. 0.25 cc. To this was added 0.8 cc of serum, or if this was varied, enough serum so that 0.5 cc of supernatant could be drawn off for titration. These, placed in Wassermann tubes, were thoroughly mixed by shaking and by stirring with a glass rod. Following this they were sealed and placed in a refrigerator at 10° Centigrade and left to "incubate" for two days.

TITRATION AND TEST OF SUPERNATANT

Supernatant from each of the tubes was drawn off by means of the 1 cc tuberculin syringe and twenty gauge needle. In order to remove as much as possible and leave the bone sample relatively dry, a flat nosed needle was used. These were made simply by passing a wire of the appropriate diameter through the needle, cutting off the beveled tip of the needle and withdrawing the wire which served to keep the needle open as it was being cut. With this needle it is possible to pick up most of the supernatant whereas the bevel tipped needle left an amount on the bottom of the tube corresponding to the length and angle of the bevel. This was also useful in titrating small amounts of supernatant.

Tests of the supernatant serum against the cell suspension are made in the same manner described for the original titration of the serum. After the cells and the supernatant have been placed in the blood group tubes and shaken at four minute intervals for thirty two minutes, they are examined. A drop is taken from each of the tubes and placed on a slide for reading under the microscope. Failure of the supernatant to agglutinate red cells is presumptive evidence that group

substance, present in the bone, has removed the agglutinins in the serum, thereby reducing its strength and its ability to agglutinate cells.

Specimens which show specific reactions, that is, which reduce the titer of one of the sera, are again immersed, after the first lot of serum has been removed, in that serum to find if they are sufficiently strong in group substance to again reduce the strength of the serum. Some specimens have been found sufficiently strong in group substance to clear the serum of its agglutinins on several successive tests.

RESULTS OF TESTS ON TEPEXPAN

Controls employed in these tests consisted of two skeletons of the Khustenete Indians, from the excavation of a site on the southwest coast of Oregon. They may not be older than the seventeenth or eighteenth century A.D. Specimens from some of these skeletons were found to consistently clear the anti-A serum of its agglutinins from one to three tubes. No specimens tested have yet given consistent results with the anti-B sera employed. Therefore all discussion of the presence of group B substance must be deferred until an effective anti-B serum is found. Tests made on specimens from Aleut skeletons previously tested by Candela did not yield uniform results with these particular sera and are not, therefore, used as controls. They did demonstrate that their substances were not causing non-specific reactions for supernatant serum removed from them showed no removal of agglutinins when the known A specimens were tested with anti-B serum or when the known B specimens were tested with anti-A serum.

Results of three tests are:

Anti-A Serum	*Test 1*		
	1:600	1:1200	1:2400
Tepexpan	—	—	—
Khustenete 20	+	—	—
Aleut 377905	+++	+	—

Test number 1 shows that the Tepexpan specimen cleared three tubes, Khustenete #20 cleared two tubes and Aleut #377905, determined A by Candela cleared only one, although it reduced the titer of a second tube. It thus seems that this particular serum is not effective on the Aleut skeletons.

Anti-A Serum	*Test 2*		
	1.800	1:1600	1:3200
Tepexpan	+	±	—
Tepexpan (retested specimen)	++++	++	+
Khustenete 16 (retested specimen)	+++	±	—

Test number 2 displays nicely the results that might be expected from a specimen which had been previously tested and a fresh specimen. The retested

specimen cleared no tubes, whereas the fresh specimen in the same test cleared one and one half tubes and reduced the titer of the third tube. The retested Khustenete #16 cleared one and one half tubes also.

Anti-A Serum	*Test 3*		
	1:200	1:400	1:800
Tepexpan	+++	++	–
Khustenete 16	++	++	–
Aleut 377904 (found B by Candela)	++++	+++	++

Test number 3 suffers from the fact that the titers of the serum used were too strong, yielding an end point of ++. Nevertheless Tepexpan and Khustenete #16 each cleared one tube and reduced the titer of the second. An Aleut specimen of group B as determined by Candela shows that there was no reaction and consequently that full agglutination resulted when its supernatant was tested against fresh A cells.

SUMMARY

The results of these preliminary tests indicate that group substance A was present in the Tepexpan skeleton These results, of course, should not be considered definitive. They must be verified by future tests, including, if possible, the use of other anti-A sera. Obviously not all sera are effective with all specimens. My failure thus far to get uniform results with the Aleut skeletons and the failure of either of the anti-B sera used to achieve positive reactions demonstrates this point in these tests.

Other factors must also be considered. The possibility of non-specific absorption should be more thoroughly investigated. The effect of the presence of bacteria should be studied. It is planned to make tests with the electron microscope and with the infra red spectrophotometer in a further attempt to demonstrate the presence of organic substance.

In conclusion, we may state that tentative evidence exists for the presence of group substance A in Tepexpan Man.

WILLIAM S. LAUGHLIN

COMPARISONS BETWEEN TEPEXPAN MAN AND OTHER EARLY AMERICANS

T. D. STEWART

COMPARISONS BETWEEN TEPEXPAN MAN AND OTHER EARLY AMERICANS[1]

FROM five desirable circumstances Tepexpan Man may be considered the best authenticated and perhaps the most instructive early skeleton yet found in America. First, the find was made by geologists (de Terra, Lundberg, Arellano) who were aware of its significance and made photographic records; second, it is said by these geologists to be a primary inclusion in a lake deposit that can be assigned to the upper Pleistocene; third, it was situated near an imperial mammoth, a typical representative of the Pleistocene fauna; fourth, it consists of an articulated skeleton with the more important parts essentially complete; and fifth, it is an adult male, the preferred age and sex for comparative purposes. Mainly lacking are immediate cultural associations. A small piece of chipped obsidian was found near the mammoth.

No other case on record presents so many desiderata. The remains from Melbourne and Vero in Florida[2] come close to meeting this test, having been found in association with a late Pleistocene fauna by geologists. Yet these skeletons, both female, were in a disarticulated state when found and consist of little more than fragmentary skulls. In addition, the primary nature of the deposit and inclusions has been disputed by geologists.

On the other hand, the remains of the Minnesota Girl (note the sex and immature age), although fairly complete and accompanied by cultural objects, were found accidentally by workmen.[3] On this account there is some doubt that the skeleton and artifacts were primary inclusions in the Pleistocene deposit. Also, neither the associated artifacts nor the associated faunal material are typical of the attributed early age.

Much the same is true of Browns Valley Man, also from Minnesota;[4] that

[1] Paper read at the 46th annual meeting of the American Anthropological Association in Albuquerque, December 28, 1947. There was no discussion. Published with the permission of the Secretary of the Smithsonian Institution.

[2] C. Wythe Cooke, *Geology of Florida* (Florida Geological Survey, 1945); and T. D. Stewart, *A Reexamination of the Fossil Human Skeletal Remains from Melbourne, Florida, with further data on the Vero Skull* (Smithsonian Miscellaneous Collections, vol. 106, no. 10, 1946).

[3] E. A. Jenks, *Pleistocene Man in Minnesota* (Minneapolis, 1936).

[4] E. A. Jenks, *Minnesota's Browns Valley Man and Associated Burial Artifacts* (Memoir, American Anthropological Association, no. 49, 1937).

is, the isolated remains were accidentally discovered in a Pleistocene gravel deposit after they had been broken and disturbed by workmen. However, it is believed that associated chipped blades, being Yuma-like in type, imply for this skeleton a respectable antiquity.

The numerous other skeletal finds with claims to antiquity make no better, and mostly even poorer showings, on the basis of this test, than the few here cited. I think, therefore, it will be agreed that on this score we have in Tepexpan Man an ideal claimant for the title of Early American. "Early" in this case, according to the geologists, means an age of 10-15,000 years.

Now in spite of this considerable age, Tepexpan Man looks like many a recent Indian. Twenty years ago this would have been sufficient reason for doubting the antiquity of the specimen. Many of our predecessors, who were acquainted with the extensive European cultural stratigraphies and were aware of the limited cultural stratigraphies here, held the view that man came to this hemisphere late in the Recent period. In defense of this view even men like W. H. Holmes resorted[5] to explaining human inclusions in American Pleistocene strata on the basis of secondary changes and the re-formation of the strata above the inclusions. With this idea in mind it was easy for Hrdlička[6] to clinch the argument against a Pleistocene age by showing that the bones lacked the primitive traits that he was inclined to think should be present if they were this old.

Two developments in the last twenty years have helped to clarify this situation. First, American archeologists with the cooperation of geologists have identified distinctive and widespread cultures to which, by correlation with glacial phenomena, they have assigned an age of 10-20,000 plus years.[7] Second, anthropologists in China have found in a cave near Peking human skeletal remains of modern form associated with an Upper Paleolithic culture which on paleontological grounds they have assigned to the Upper Pleistocene.[8] Most every one is now willing to accept this evidence as positive proof of the presence of man on this hemisphere at the close of the Ice Age, and to look for a modern physical appear-

[5] W. H. Holmes, *On the Antiquity of Man in America* (Science, vol. 47, no. 1223, pp. 561-562, 1918).

[6] Hrdlička, Aleš, *Skeletal Remains suggesting or attributing to Early Man in America* (Bulletin, Bureau of American Ethnology, no. 33, 1907); *Recent Discoveries attributed to Early Man in America* (Bulletin, Bureau of American Ethnology, no. 66, 1918); *Early Man in America* (in "Early Man," Philadelphia, 1937).

[7] Frank H. H. Roberts, Jr., *Developments in the Problem of the Paleo-Indian* (Smithsonian Miscellaneous Collections, vol. 100, 1940); and *The New World Paleo-Indian* (Smithsonian Report for 1944, 1945).

[8] W. C. Pei, *A Preliminary Report on the Late-Paleolithic Cave of Choukoutien* (Bulletin Geological Society of China, 1934); Weidenreich, Franz, *On the Earliest Representatives of Modern Man Recovered on the Soil of East Asia* (Peking Natural History Bulletin, 1939).

ance in this early man. Clearly, then, the modern appearance of Tepexpan Man no longer is to be regarded as inconsistent with the geological setting in which he was found.

Now it is one thing to grant man an early appearance in America and another to date either his first appearance or any one of his early physical or cultural manifestations. Chronology is out of my domain, but it has a bearing on the comparisons I wish to make. Therefore, I am constrained to remark on the range of error in the dates offered us. It should be obvious that any date expressed in terms of $\pm$5-10,000 years is only a guess. Whether Tepexpan Man is older or younger than the Melbourne and Vero women, or the Minnesota Girl, or the Browns Valley Man, or any other putatively Early American (including hypothetical Sandia Man), is still a guess. All we can say is that if these specimens have valid claims to the antiquity assigned to them by the geologists, they are as a group the oldest thus far discovered in the New World.

The question of the validity of the claims to antiquity, made on behalf of each of the putative Early Americans, as I have indicated, is still open to debate. Some weak point can be found almost always in the circumstances surrounding the discovery of any object buried in the earth. This is especially true when the situation is complicated by accidental discovery, as has often been the case Because the doubts regarding the true antiquity of such specimens are a handicap in reaching generalizations about their comparative morphology, I propose to surmount this difficulty by assuming that the antiquity of those I shall select for comparison is as well established as that of Tepexpan Man.

When we look around in the limited sample of putatively Early Americans for fairly complete skulls to compare with that of Tepexpan Man, we come upon the following: Males—Browns Valley,[9] Lansing,[10] Novusmundus,[11] Wyoming I,[12] and Confins;[13] females—Melbourne,[14] Vero,[15] Minnesota,[16] Wyoming III[17] and Punin.[18] Time does not permit the consideration of others, nor these in much detail. I repeat that this is an arbitrary selection of the better preserved skeletal

[9] Jenks, *op. cit.,* 1937.

[10] Hrdlička, *op. cit.,* 1907.

[11] J. D. Figgins, *New World Man* (Colorado Museum of Natural History, 1935).

[12] W. W. Howells, *Crania from Wyoming resembling "Minnesota Man"* (American Antiquity, vol. 3, no. 4, 1938).

[13] H. V. Walter, A Cathoud, and Anibal Mattos, *The Confins Man* (In "Early Man," Philadelphia, 1937).

[14] Stewart, *op. cit.,* 1946.

[15] *Ibid.*

[16] Jenks, *op. cit.,* 1936.

[17] Howells, *op. cit.*

[18] Louis R. Sullivan and Milo Hellman, *The Punin Calvarium* (American Museum of Natural History, 1925).

remains with claims to antiquity and we cannot be sure all of these are early, much less equally early.

One of the notable characteristics of the Tepexpan skull is its moderate roundheadedness. The cranial index is 80 (I shall cite round figures for the most part). I know of no other Early American with so round a head. Nearest thereto is the Minnesota Girl with an index of 77, and the Wyoming III woman with an index of 76. The others range from 69 in Confins to 73.5 in Browns Valley and Lansing—an average of 72 for 8. In addition, the Lagoa Santa group of Brazil, of which Confins is the last one reported, has a range from 68 to 74, with an average of 71 for 17 specimens.[19]

It is a surprise that Tepexpan Man is roundheaded, because the indications seem to be that the Early Americans should be longheaded. The peripheral distribution of longheads through America in recent times, as pointed out by Dixon,[20] suggests this. And the low cranial indices of the other Early Americans already listed bear this out. Nevertheless, it would be strange if a longheaded population did not include in its range of variation some moderately roundheaded individuals. For this reason it seems to me unreasonable to look upon this one exception as a representative of a brachycranic group rather than a natural variant in a predominantly dolichocranic population. It could be claimed, of course, that Tepexpan Man retained some occipital flattening from childhood. Of this I can see no indication, for the occiput is symmetrical and naturally rounded.

We turn now to the height of the Tepexpan skull. The distance between basion and bregma, when compared to the mean of the two horizontal diameters, can be classed as moderately high. This ratio is known as the mean height index and amounts to 84.5. Unlike the cranial index of Tepexpan Man, his mean height index is exceeded in a number of Early Americans: Browns Valley and Lansing, 85; Novusmundus, 89; Confins, 94; average of 8 highheads in the Lagoa Santa group, 87 (range 85 to 89). On the other hand, the mean height indices of a number of other Early Americans fall short of 84.5 and may be classed as medium to low: Minnesota, 80; Punin, 78; Wyoming III, 76.5; average of 5 lowheads in the Lagoa Santa group, 83 (range 79 to 84). In this indicial division Tepexpan Man is on the side of the majority, but not among the highest headed.

It is not surprising, at least to me, that Tepexpan Man is fairly highheaded. In my studies of the distribution of the mean height index in America,[21] I have shown that the highheads are distinctly separated from the lowheads and more peripherally located. This has led me to believe that the lowheads are a later

[19] T. D. Stewart, *Skeletal Remains of South American Indians* (in press).

[20] Roland B. Dixon, *The Racial History of Man* (New York, 1923).

[21] T. D. Stewart, *Some Historical Implications of Physical Anthropology in North America* (Smithsonian Miscellaneous Collections, 1940); *Distribution of Cranial Height in South America* (American Journal of Physical Anthropology, 1943).

element. Also, since the lowheads among the putatively Early Americans come from areas where the recent Indian occupants were lowheads, this has seemed to me an additional reason for doubting their antiquity. Here again, however, the question of normal variants arises, and the answer must await more discoveries.

Another characteristic of Tepexpan Man, which shows up clearly in the reconstructed head, is the prominence of the cheek bones. Unfortunately, loss of the teeth rules out face height as a standard against which to measure this feature. Perhaps the next best thing to compare it to is the spread of the frontal bone. Relative then to the smallest frontal breadth the breadth across the zygomata is 141 per cent, or expressed reciprocally, 71. Among the males of the Early Americans selected for comparison only Confins exceeds this figure (72), and in this case the breadth across the damaged zygomata may be underestimated (131 mm). On the other hand, this index is around 69 in the Lansing skull; it is 66 in Wyoming I and Browns Valley; and it may drop to around 62 in Novusmundus. Now, of course, Tepexpan Man is much more roundheaded than these other Early Americans and this in part probably explains the broader face. Yet a sex factor probably also enters into this ratio for it is higher still in some of the females under consideration.

Good data on this ratio for the American Indian population are scarce. From a hasty sampling, however, I feel that the average may be around 68-69 in males and somewhat higher in females. All that can be said is that the figures quoted for our small sample of Early Americans are near the Indian averages.

We go next to the orbits. That Tepexpan Man has relatively high orbits is shown by the orbital index, which is 85. This figure, which is based upon orbital breadth from dacryon, is well within the range of the other Early Americans. With one exception these fall between 82 and 94. The exception is Punin, with an index of 72.5.

The distribution of the orbital index in recent Indians has not been worked out in detail. From what I can see there seems to be no significant segregation of the extremes. A hasty survey of the literature reveals that the index ranges on the average mostly from 85 to 90. Individual cases of low orbits, such as in Punin, are on record, but characteristically the orbits are high in American Indian crania.

Low orbits often go with a low face. This type of face, when combined with a very long head, has been described as disharmonic. Such a combination is seen in none of the Early Americans under consideration except possibly in Punin. In general, the disharmonic type is not characteristic of recent Indian skulls.

I shall not analyze the nasal index in detail because its great variability makes it impossible to arrive at any significant conclusion. It is sufficient to point out that the index for Tepexpan Man amounts to 50, which is close to the general average for recent American Indians.

It would be unprofitable for the same reason to go into the matter of cranial capacity. Besides, many of the earlier determinations are inaccurate. Although the Tepexpan skull does not look especially large, the capacity undoubtedly is above 1500 cc. Capacities of this size are not unusual among recent American Indians.

In keeping with his head size Tepexpan Man was fairly tall—170 cm, or about five feet, seven inches. We know nothing about this feature in other Early Americans. Since this figure is above the average for present-day Mexican Indians and since Middle America in general is an area where Indian stature is low today, this suggestion of a higher stature in earlier times possibly can be connected with the indications that certain environmental factors in this area have acted as a growth depressant.[22]

So much for metrical characters. When I first saw the skull of Tepexpan Man in Mexico City before the face was reconstructed, I identified his type as the one "Hrdlička was wont to call Algonkin" (see Appendix C). I was concerned then not so much with typological accuracy as with the need for emphasis on the basically Indian character of the remains to counteract Weidenreich's implications of its primitiveness (see Appendix C). Now that the face is reconstructed, I am told by those who have made more of a study of Indian types that the Tepexpan skull is better classed under Hrdlička's Gulf type, or Georg Neumann's Centralid type.

Fortunately the terms Gulf and Centralid have no connotations of Old World origins, so we can leave it to the fiction writers to puzzle out where he migrated from and how. Other Early Americans have not been so fortunate. Punin and Novusmundus have been called Australoid and Pseudo-Australoid; the Minnesota Girl has been called by one person Eskimoid and by another Australoid or Negroid.[23] The others were found before type designations came into vogue. To me they all look like Indians.

This tendency to characterize skulls in terms of the primitive is, I suspect, associated in some way with the glamor of antiquity. Some physical anthropologists are impelled to call a skull with big brow-ridges Australoid in the same way that some archeologists are impelled to call a leaf-shaped blade Folsomoid; the primitive and the old have a fascination as well as news value.

The disagreement among physical anthropologists regarding the naming of types indicates the subjective nature of these identifications. Until type designations are placed on a more objective basis with a terminology free from implications of relationship, they will remain an unsatisfactory comparative tool and continue to be misleading.

Perhaps we will get a better perspective on the Early Americans if we compare them with the known Upper Paleolithic population of Asia and Europe. I

[22] C. A. Mills, *Climatic Effects on Growth and Development* (American Anthropologist, vol. 44, pp. 1-13, 1942).

[23] See Earnest A. Hooton, *Up From the Ape* (New York, 1946), p. 407.

hesitate to make this comparison for the same reason that I would hesitate to compare a group of Pueblo Indians with a group of Chinese, or for that matter with a group of Incas from Peru. So many variables affect the comparison that interpretation becomes impossible. Nevertheless, the Upper Pleistocene populations of America, Asia and Europe diverged at some time and place from the same common stock. Presumably those of America and Asia would have more in common but of this we know very little. It is at least of academic interest, therefore, to compare the physical traits of these distantly related peoples, living in far separated areas, if we assume that they existed more or less contemporaneously.

I am aware of a different handicap in making this comparison. Whereas I personally have seen some of the Early American skulls and great numbers of those of recent American Indians, I have seen only a few casts of the classical Asiatic and European Paleolithic skulls. Of course I have examined also the measurements of others, but allowance should be made for the fact that my main impression comes from these casts.

In brief, both the Asiatic and European Upper Paleolithic skulls tend to be more massive than the Early Americans. The Old Man of the Upper Cave of China has a head length of 204 mm and ten of the European males in Morant's list[24] exceed 200 mm. Like the Americans they are predominantly longheaded (average C.I. 73-75). Yet height of head is much more variable, and the tendency is to lowheadedness (only four out of nineteen are definitely high, whereas fifteen are lower than Tepexpan). The disharmonic face of these Old World Paleolithic skulls has often been commented upon, and the fronto-zygomatic ratio tends to be high. So far as I can discover, all but Chancelade have orbital indices below 80, whereas, you will recall, the Early Americans, with the exception of Punin, have indices above 80. These differences are very real, I am convinced, and need emphasis.

We are accustomed to rate as primitive the combination of massiveness, longheadedness, and lowness of head, face and orbits. If this is correct, then the opposite, which is characteristic of the Early Americans and the American Indians in general, is less primitive. This gets us back to the problem with which our predecessors struggled, namely, could man have come to this hemisphere at the close of the Pleistocene looking no different than the recent Indians? To my way of thinking, Tepexpan Man strengthens the cases of the previous claimants to antiquity and collectively they provide strong evidence for an affirmative answer. The uncertainty that withholds an outright affirmative answer to this question stems mostly from the lack of an accurate chronology and the residuum of doubt regarding the authenticity of most of the American finds.

[24] G. M. Morant, *A Biometric Study of the Upper Paleolithic Skulls of Europe* (Annals of Eugenics, vol. 4, pp. 109-214, 1930-31).

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EXPLANATION OF PLATES

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PLATE 1. *Panorama of Tepexpan Lake Plain.*

LEFT: excavation pit I, in foreground stakes marking equipotential lines of geophysical survey, RIGHT. basalt bluffs with Zacatenco beach along lowest tree line; in background Cerro de Chiconautla left and Cerro de Tlalhuilco right.

PLATE 2. *Lake Flats and Long Ditch, Tepexpan.*

A, view from Zacatenco beach on lake flats, Tepexpan. B, sequence of geologic formations in long ditch, Tepexpan. In foreground excavation pit ARV II, in background Fossil Man site (arrow); along walls of ditch white caliche layer below swamp and soil formations.

PLATE 3 *Wall Sections*

A, wall sections at Fossil Man site, Tepexpan. 1—gray top soil; 2—dark soil with saline crust at base, 3—Totolzingo marl, 4—caliche with lens of pumice; 5—El Risco sandy clay with position of fossil skull marked B, wall section in excavation pit ARV II. Numbers same as in Fig 1, bottom layer 6: El Risco sand.

PLATE 4. *El Risco and Tepexpan Site.*

A, El Risco beach III and Zacatenco beach at El Risco. White Zacatenco beach gravel overlain by sherd refuse; volcanic rock below encrusted with thinolite marking lowest El Risco beach (Upper Pleistocene). B, Totolzingo earth on calichized El Risco sand, Totolzingo. C, Dr. Lundberg surveying with geophysical apparatus at Tepexpan. D, forearms and hand of Tepexpan Man in position.

PLATE 5. *Excavation Trench.*

A, excavation trench between pit II and III, Tepexpan. B, Dr. Romero excavating Tepexpan Man. C, Dr. de Terra looking at skull of Tepexpan Man.

PLATE 6. *Arroyos at Tepexpan and Totolzingo*

A, arroyo in upper hill slopes near Tepexpan. Calichized Old Becerra alluvium. B, the Totolzingo arroyo. White El Risco beach II gravel below volcanic ash. C, wall section in Totolzingo arroyo. On surface white caliche on Old Becerra alluvium

PLATE 7. *Zacatenco Beach gravel at Zacatenco.*

Basalt and detritus encrusted with thinolite overlain by washed adobe refuse of Zacatenco III culture level.

PLATE 8. *Jaws and Teeth of Fossil Elephant.*

A, lower mandible of fossil elephant from ARV I site. B, lower mandible of fossil elephant from ARV I site. C, upper molars of fossil elephant from ARV I site. D, upper molars of fossil elephant from hospital site.

PLATE 9. *Artifacts, Tepexpan and Chalco.* A, graver and endscraper, obsidian (4A-2), San Juan culture; B, graver, obsidian (4A-3), San Juan culture; C, base of projectile point, basalt (2C-3), Chalco culture; D, point reject, basalt (2C-2), Chalco culture; E, graver, obsidian (4A-1), San Juan culture; F, bone point (3-3), San Juan culture; G, point reject, basalt (2C-6), Chalco culture; H, discoidal scraper, basalt (2C-4), Chalco culture; I-J, plano-convex scraper, basalt (12A-3)—scale in centimeters—Chalco culture.

PLATE 10. *Tepexpan Artifacts.* A, graver, chalcedony (8D-28), Tepexpan industry; B, same (3-1), San Juan culture; C, scraper, flint (8D-18), Tepexpan industry; D, endscraper, flint (8D-23), Tepexpan industry; E, same, flint (8D-34), Tepexpan industry; E_1, point fragment with channel flake (8D-22), Tepexpan industry; E_2, point fragment notched (25A-16), Tepexpan industry; F, point, quartz (8D-53), Tepexpan industry; G, point, quartz (8D-15), Tepexpan industry; H, point, quartz (8D-52), Tepexpan industry; I, same, opal (8D-59), Tepexpan industry; J, endscraper, quartz (17-4), Tepexpan industry; K, point reject, quartz (8D-28), Tepexpan industry; L, graver, flint (8D-61), Tepexpan industry; M, scraper, quartz (8C-2), Tepexpan industry.

PLATE 11. *Artifacts, Tepexpan and Chalco.* A, convex scraper, silicified tuff (28-5), ? industry; B, scraper, silicified tuff (26-1), ? industry; C, endscraper, quartzite (28-13), ? industry; D, knife, flint (8D-33), Tepexpan industry; E, endscraper, flint (8D-30), Tepexpan industry; F, point, quartz (8D-17), Tepexpan industry; G, convex scraper, flint (8D-37), Tepexpan industry; H, sidescraper, quartz (8D-58), Tepexpan industry; I, plano-convex scraper, flint (17-5), Tepexpan industry; J, pestle with caliche patination, basalt (8E), Chalco culture.

PLATE 12. *Artifacts, Tepexpan and Chalco.* A, spearpoint, basalt (Tezoyuca), Chalco culture; B, point, basalt (8C-9), Chalco culture; C, same (P-3), Chalco culture; D, endscraper, basalt (8C-24), Chalco culture; E, sidescraper, basalt (8C), Chalco culture, F, concave scraper, basalt (Chu-64), Chalco culture; G, chopper, basalt (Chu-32), Chalco culture; H, plano-convex scraper, basalt (Chu-), Chalco culture; I, plano-convex scraper, chalcedony, Tepexpan industry.

PLATE 13. *Chalco Artifacts.* A, triangular scraper, basalt (24-9), Chalco culture; B, same (24-10), Chalco culture; C, plano-convex scraper, basalt (25A-10), Chalco culture, D, chopper, basalt (24-2), Chalco culture.

PLATE 14. *Chalco Artifacts.* A, chopper, basalt (8D-3), Chalco culture; B, endscraper, basalt (9A-2), Chalco culture; C, chopper-scraper, basalt (8A-10), Chalco culture; D, discoidal scraper, basalt (Chu-51), Chalco culture; E, same (Chu-50), Chalco culture; F, ovoid scraper, basalt (24-6), Chalco culture; G, same (8D-2), Chalco culture.

PLATE 15. *Chalco Artifacts.* A, sidescraper, basalt (14-1), Chalco culture; B, endscraper, basalt (8A-5), Chalco culture; C, plano-convex scraper, andesite (Chu-41), Chalco culture; D, convex endscraper, basalt (8C-12), Chalco culture; E, chopper, basalt (9-2), Chalco culture; F-G, plano-convex scraper, silicose limestone (19-1), Chalco culture.

PLATE 16. *Chalco Artifacts.* A, discoidal scraper, basalt (8C-10), Chalco culture; B, convex scraper, basalt (12A-1), Chalco culture; C, same (Chu-26), Chalco culture; D, endscraper, basalt (Chu-25), Chalco culture; E, plano-convex scraper, rhyolite (25-A), Chalco culture; F, same, basalt (Chu-68), Chalco culture.

PLATE 17. *Chalco Artifacts.* AB, handmill stones, andesite (15-2, 3), Chalco culture; C, same, basalt (8D-41), Chalco culture, D, same, basalt (8B-2), Chalco culture; E, pestle, basalt (2B-4), Chalco culture; F, same, basalt (15-2), Chalco culture; G, handmill stone, basalt (8A-8), Chalco culture.

PLATE 18. *Artifacts (San Luis Potosi, Tepexpan, Chalco).* A, folsom-like point, flint, San Pedro cave, Rio Verde valley, San Luis Potosi; B, convex scraper, quartz (25A-5), ? Tepexpan industry; C, double endscraper, quartz (18-1), Tepexpan industry; D, beaked endscraper, rhyolite tuff (28-11), Tepexpan industry; E, endscraper, rhyolite tuff (28-9), Tepexpan industry; F, grave, basalt (Chu-33), Chalco culture; G, end-scraper, basalt (Chu-31), Chalco culture; H, plano-convex scraper, rhyolite tuff (25A-17), Tepexpan industry; I, discoidal scraper, flinty limestone (19-4), Chalco culture.

PLATE 19. *Teotihuacan Artifacts.* A, projectil point, obsidian (8F-6), Teotihuacan II-III; B, same, obsidian (8C-15), Teotihuacan II-III; C, base of spearpoint, obsidian (8F-1), Teotihuacan II-III; D, projectil point, obsidian (8D-4), Teotihuacan II-III; E, tip of projectil point, obsidian (Cuanalan), ? Archaic; F, sidescraper, obsidian (10-3), Teotihuacan II; G, scraper, obsidian (Chu-7), Archaic burial; H, beaked scraper, obsidian (8D-11), Teotihuacan.

PLATE 20. *Western Slope of Iztaccihuatl and Basalt Bluff Site.*
A, panoramic view of western slope of Iztaccihuatl. Taken from about 3900 m above sea level; AM-terminal moraine at 4350 m. of post-Pleistocene Ayolotepito advance. In foreground, ice scored bedrock and thin moraine mantel of Late Pleistocene glaciations. B, excavation at site 3 (bluff site) near Tepexpan. Basalt lava flow in background. C, basalt bluffs of Tepexpan with excavation site 2 in foreground and site 3 in background.

PLATE 21. *The Carved Bone of Tepexpan.*
A, underside. B, upper side. C, sideview.

PLATE 22. *Pit No. 2.*
Showing the enlargement made to recover the Tepexpan skeleton. The skull has been moved from its original position to obtain a better photograph.

PLATE 23. *Eng. A. R. V. Arellano at the Site.*

PLATE 24. *The Author Examining the Skeleton in situ.*

PLATE 25. *Views of the Endocast.*
A, anterior. B, posterior. C, right lateral. D, left lateral. E, vertical.

PLATE 26. *The Skull after Restoration.*
A, norma frontalis. B, norma verticalis. C, normal lateralis dexter.

PLATE 27. *The Skull after Restoration.*

D, norma occipitalis. E, norma basilaris. F, norma lateralis sinister.

PLATE 28. *The Lower Jaw.*

Anterior, left lateral and superior views. The marked abrasion and the absence of molars may be noted.

PLATE 29. *The Atlas, Epistropheus and Talus.*

ABOVE: the atlas and epistropheus, showing exostosis. BELOW: lower surface of the talus (white parts restored).

PLATE 30. *Humeri.*

A, right, anterior and inner surfaces B, left, anterior and outer surfaces.

PLATE 31. *Ulnae.*

A, right, anterior and outer surfaces. Note the healed fracture in the lower portion of the shaft. B, left, outer and anterior surfaces.

PLATE 32. *Radii.*

A, right, anterior and inner surfaces. B, left, anterior and outer surfaces.

PLATE 33. *Femora.*

A, right, anterior and inner surfaces. B, left, anterior and outer surfaces.

PLATE 34. *Tibiae.*

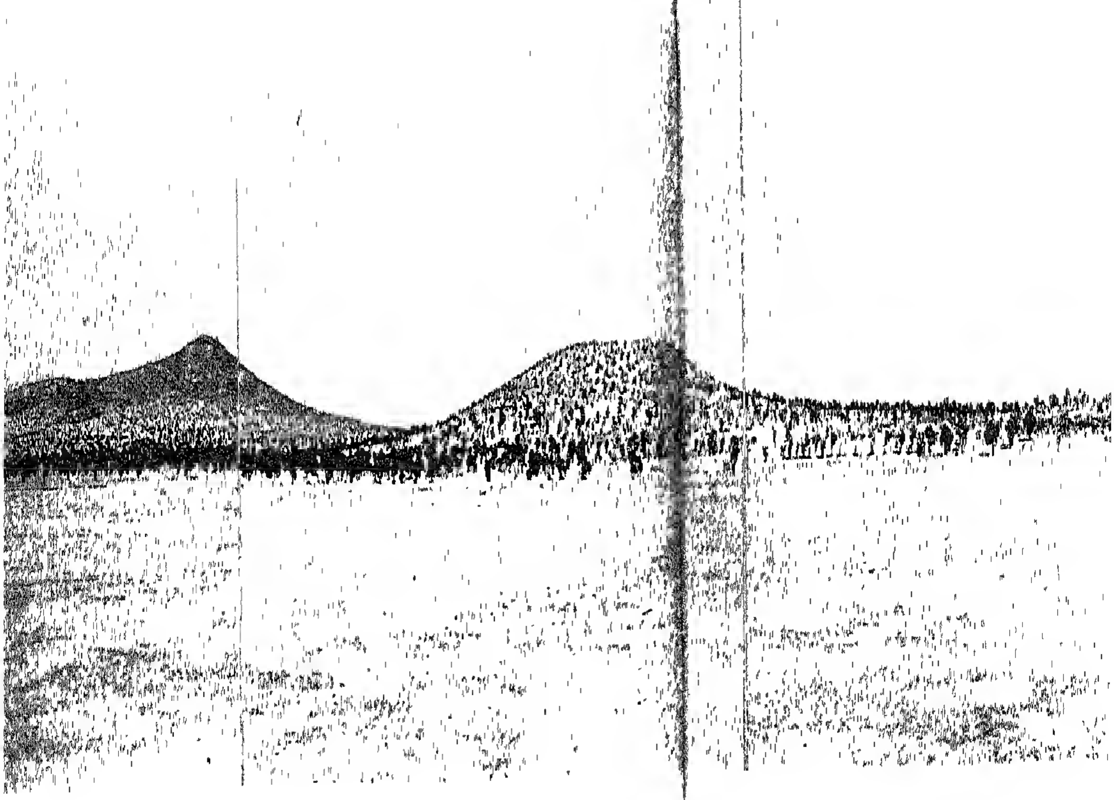
A, right anterior and outer surfaces. B, left anterior and inner surfaces.

PLATE 35. *Radiographs.*

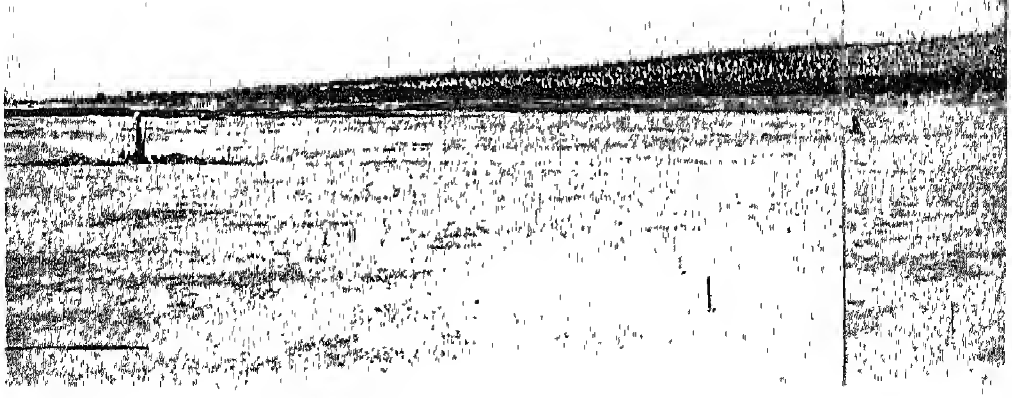
A, B, C, the Maxillai. D, E, F, the Mandible. In B, note the supernumerary tooth in the palate, just to the right of the sagittal plane. These radiographs were made by Dr. S. Fastlicht (Appendix D).

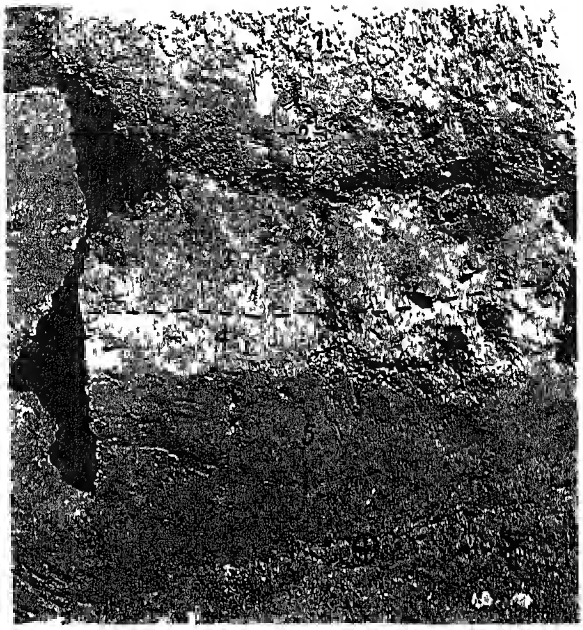
PLATES 36 AND 37. *Comparative Views.*

Some comparative views of Tepexpan skull (A) and No. 99/9622 from Ticoman (B). Courtesy of the American Museum of Natural History.



Panorama of Tepexpan Lake Plain





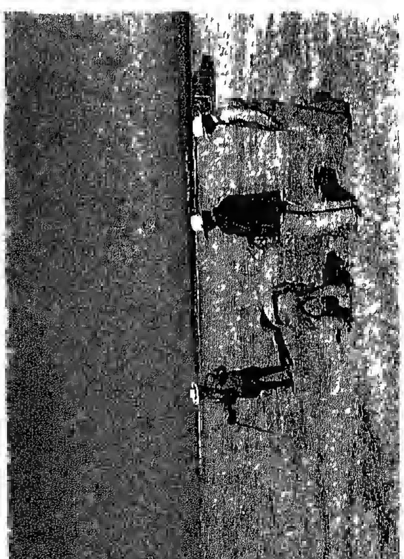
A

B

Wall Sections

A

B



C

D

TEPEXPAN SITE

A

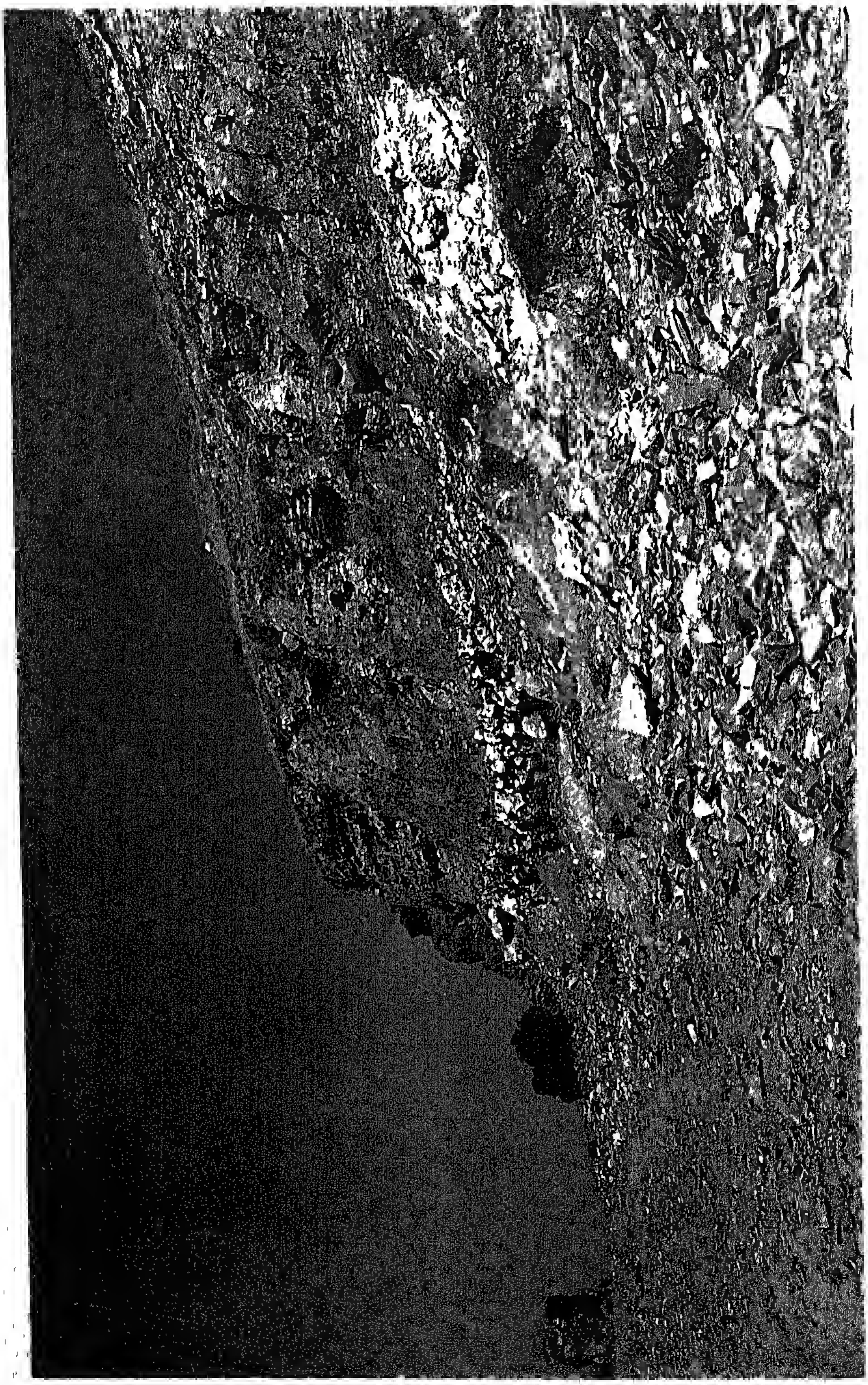
B

C

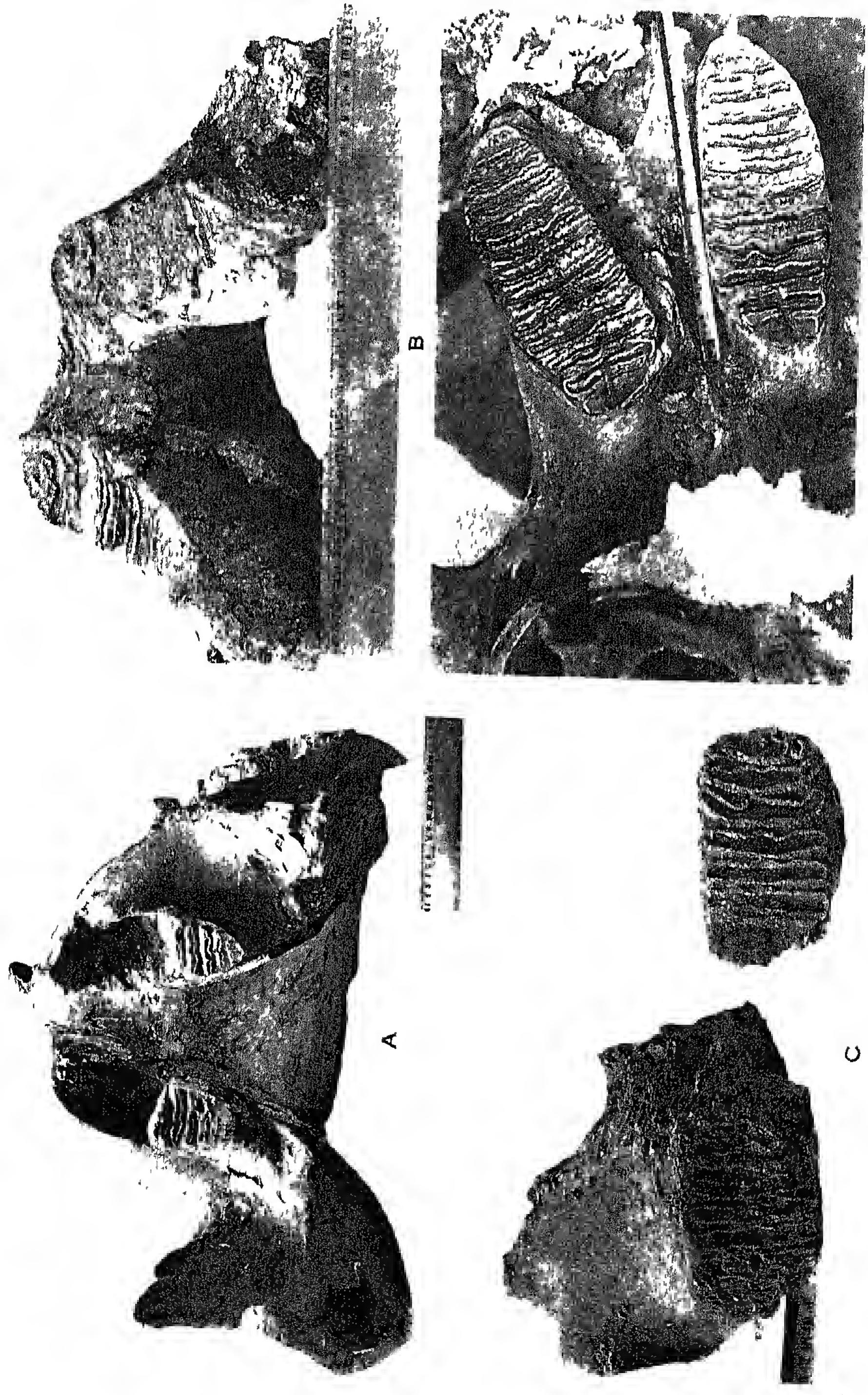
EXCAVATION TRENCH

A B C

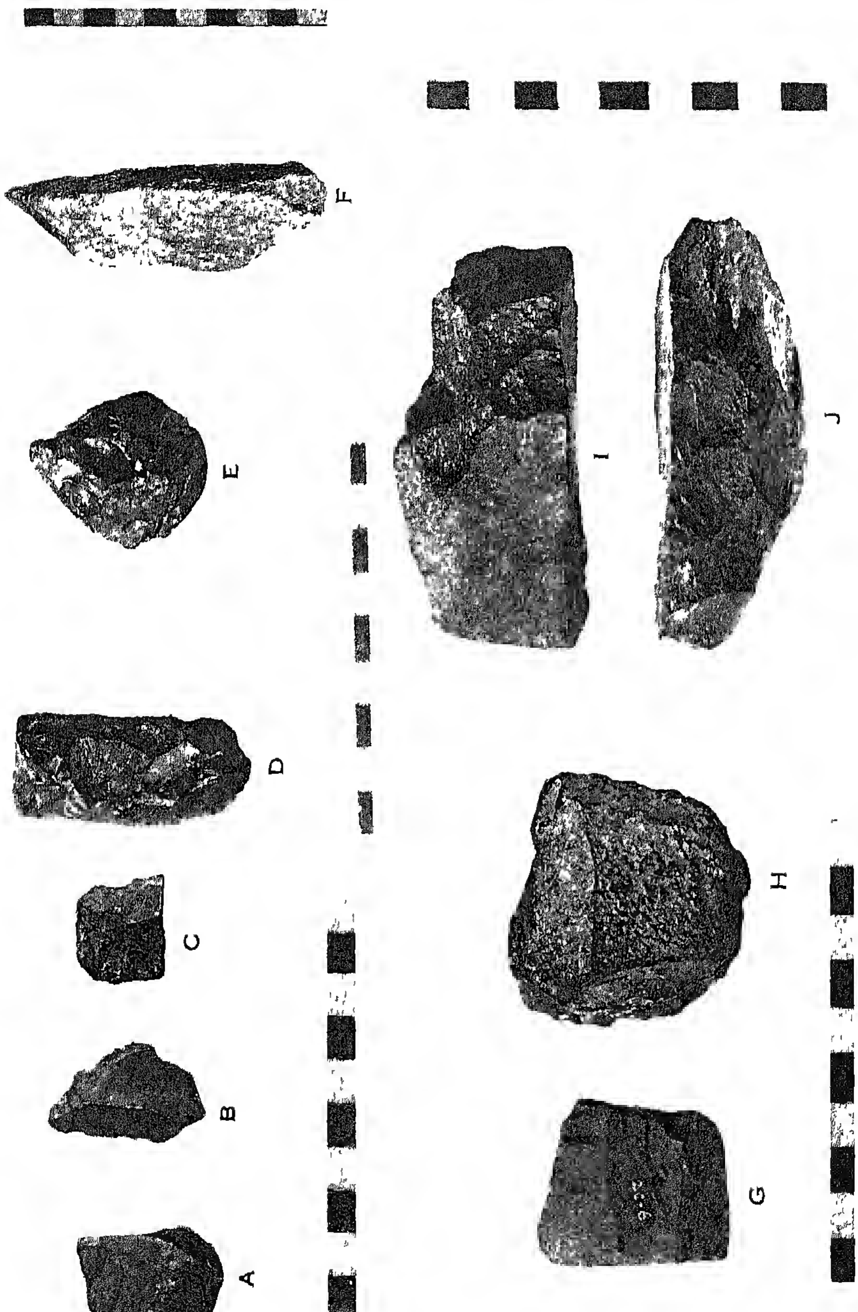
ARROYOS AT TEPEXPAN AND TOTOLZINGO



ZACATENCO BEACH GRAVEL

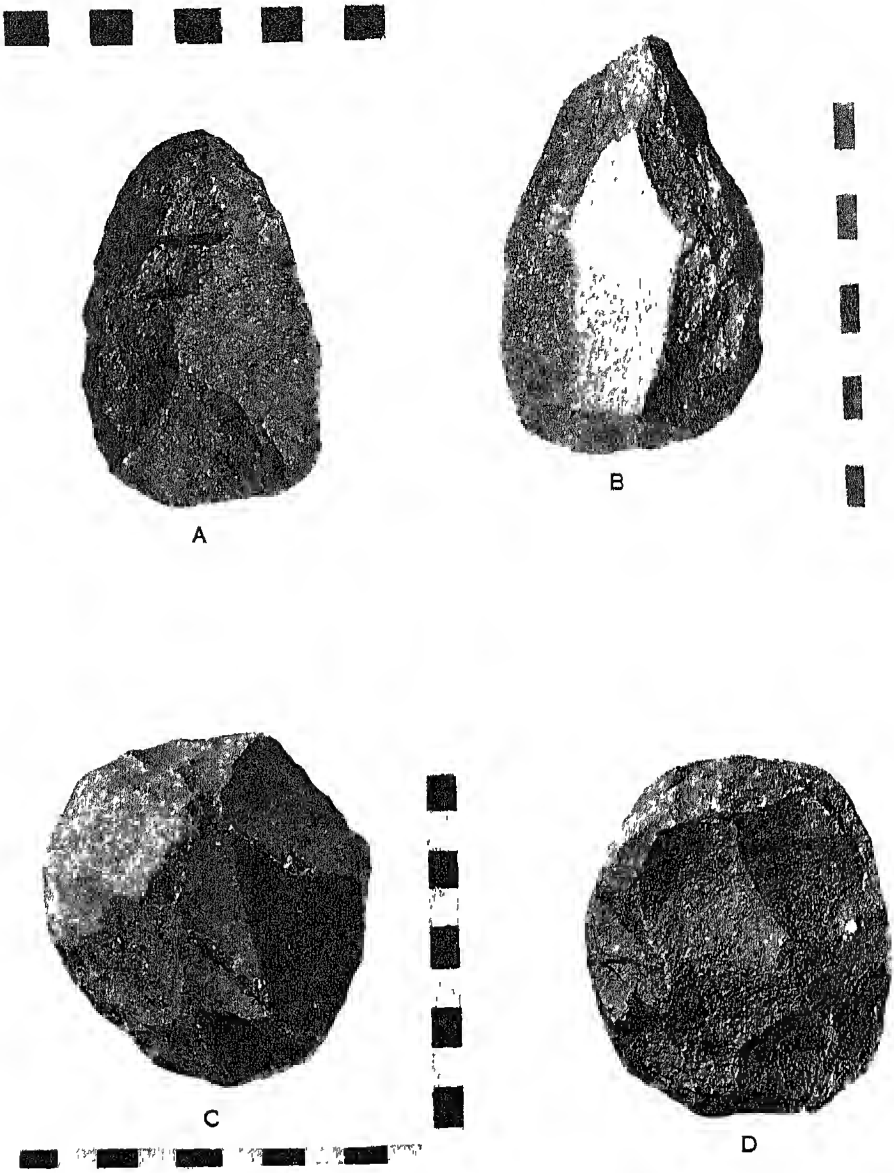


JAWS AND TEETH OF FOSSIL ELEPHANT

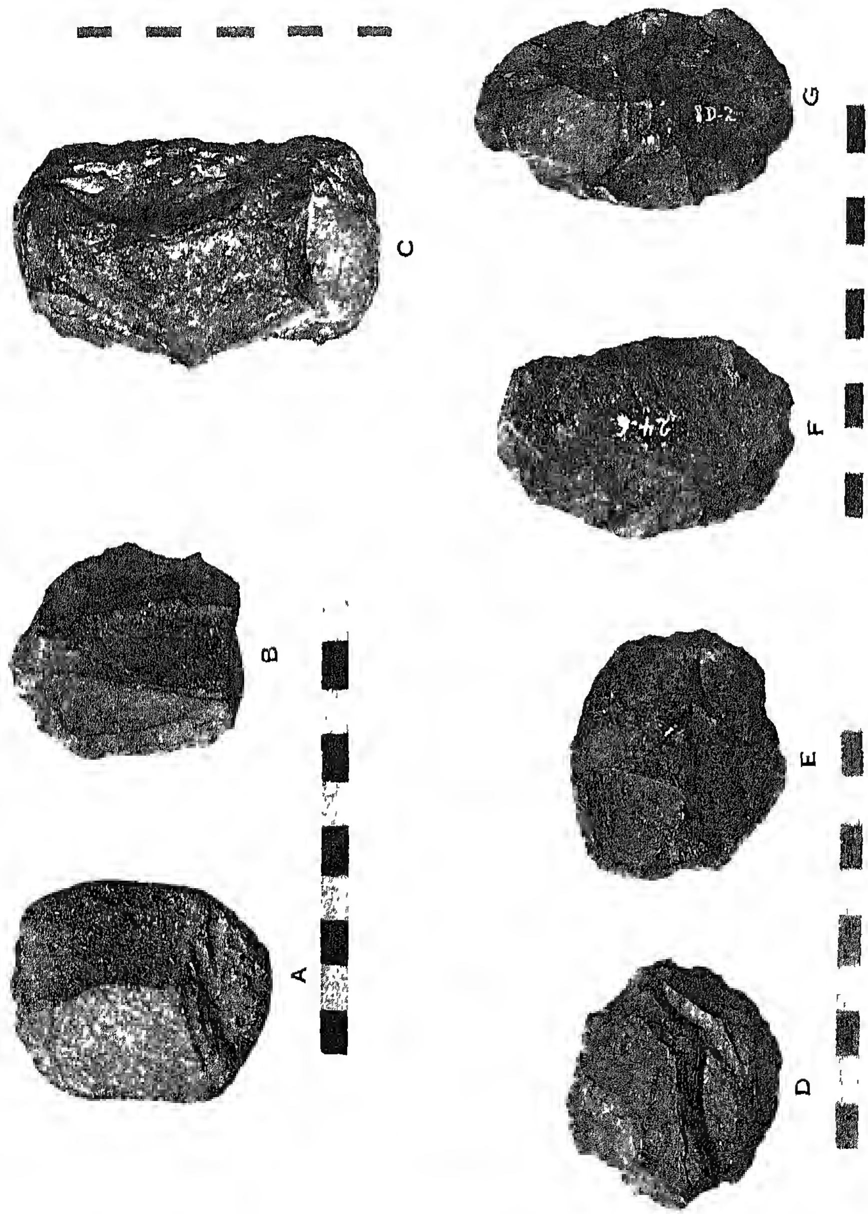


ARTIFACTS, TEPEXPAN AND CHALCO

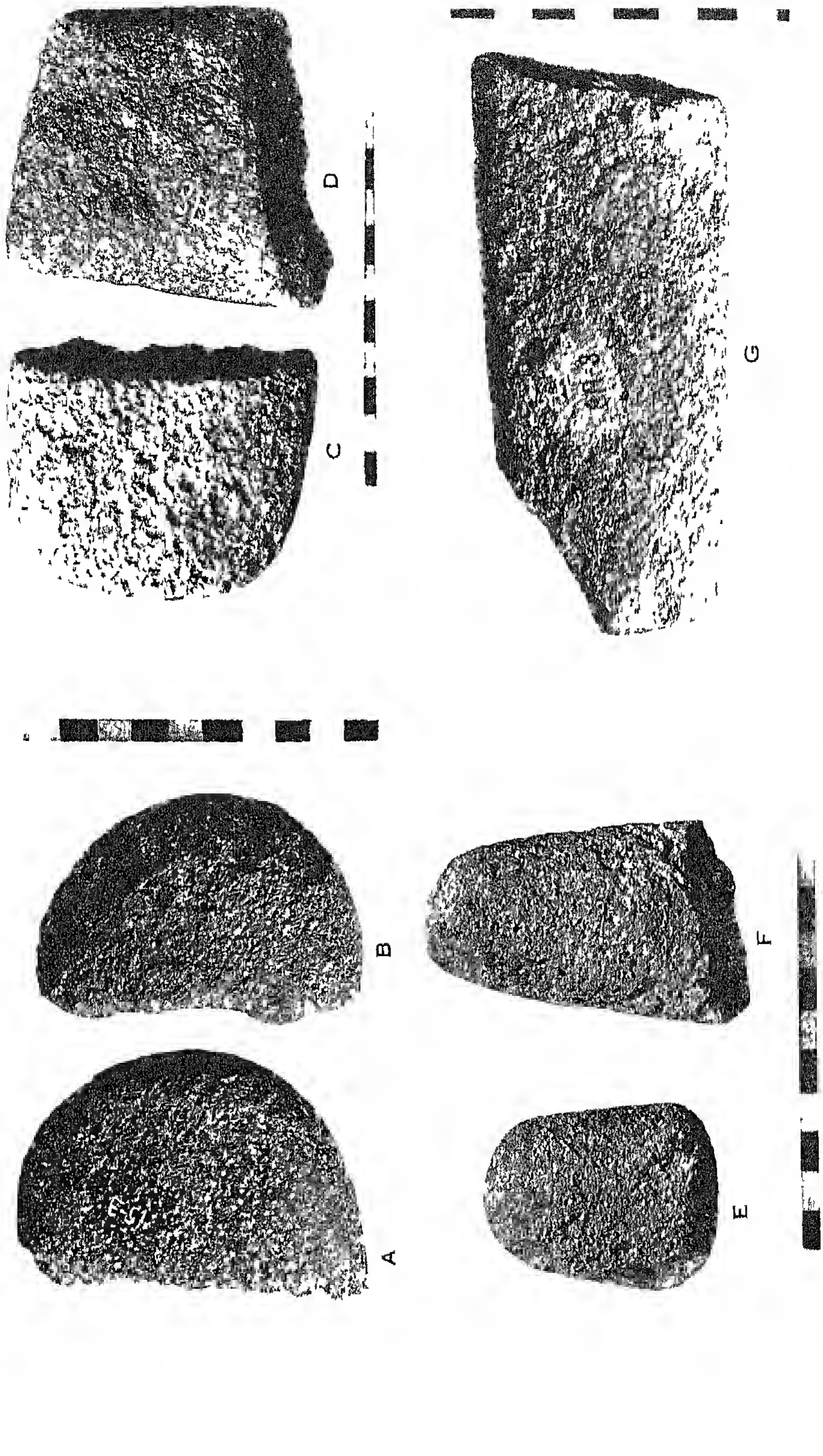
Tepexpan Artifacts



CHALCO ARTIFACTS



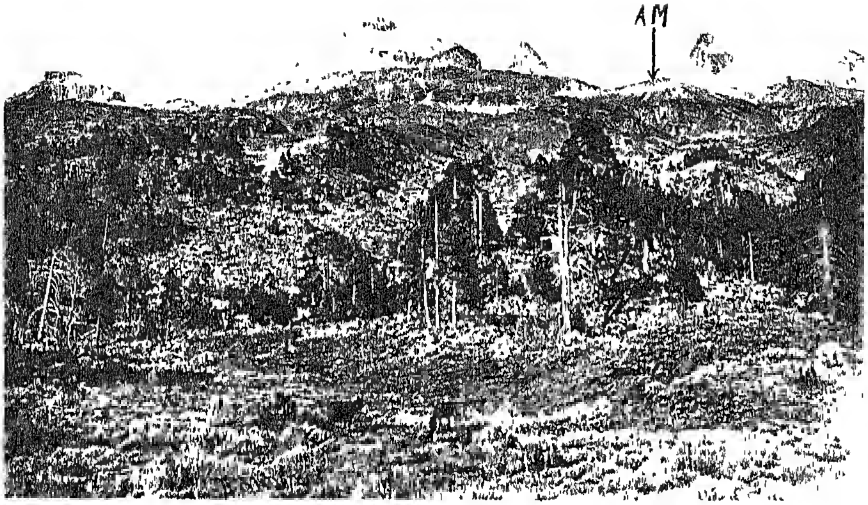
CHALCO ARTIFACTS



CHALCO ARTIFACTS

ARTIFACTS (SAN LUIS POTOSI, TEPEXPAN, CHALCO)

Teotihuacan Artifacts



A

B

C

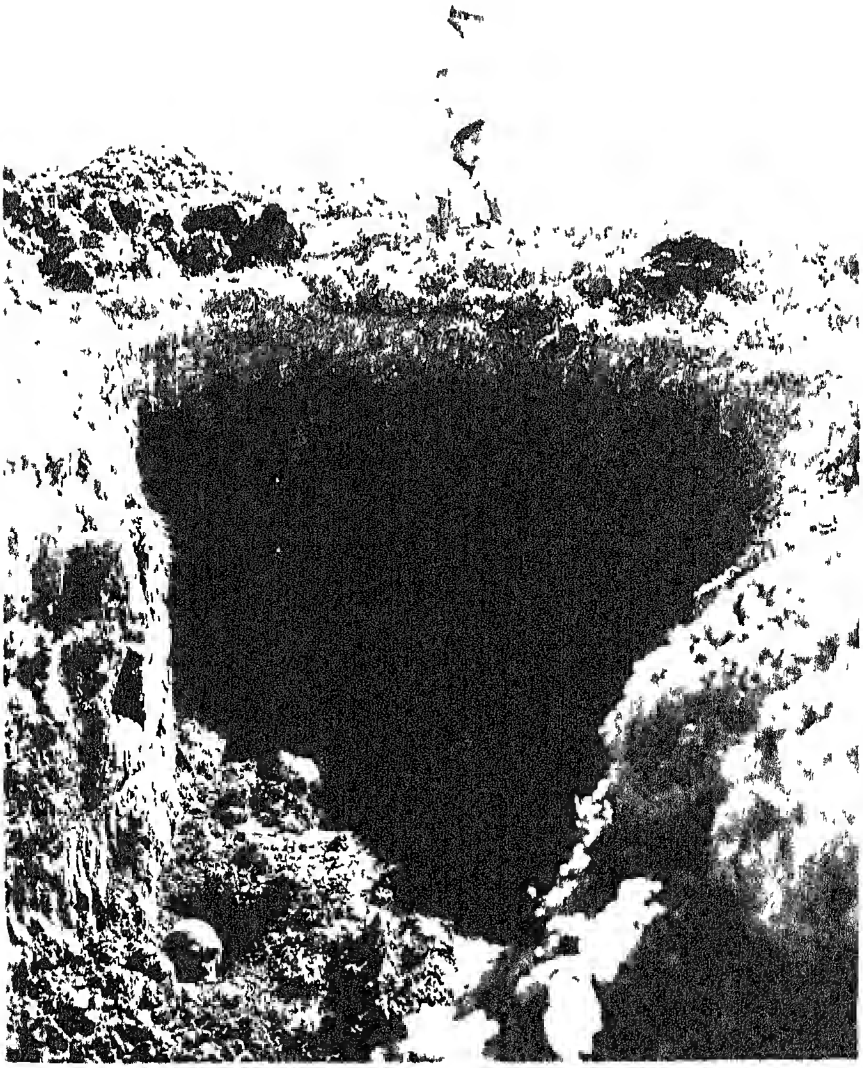
WESTERN SLOPE OF IZTACCIHUATL AND BASALT BLUFF SITE

C

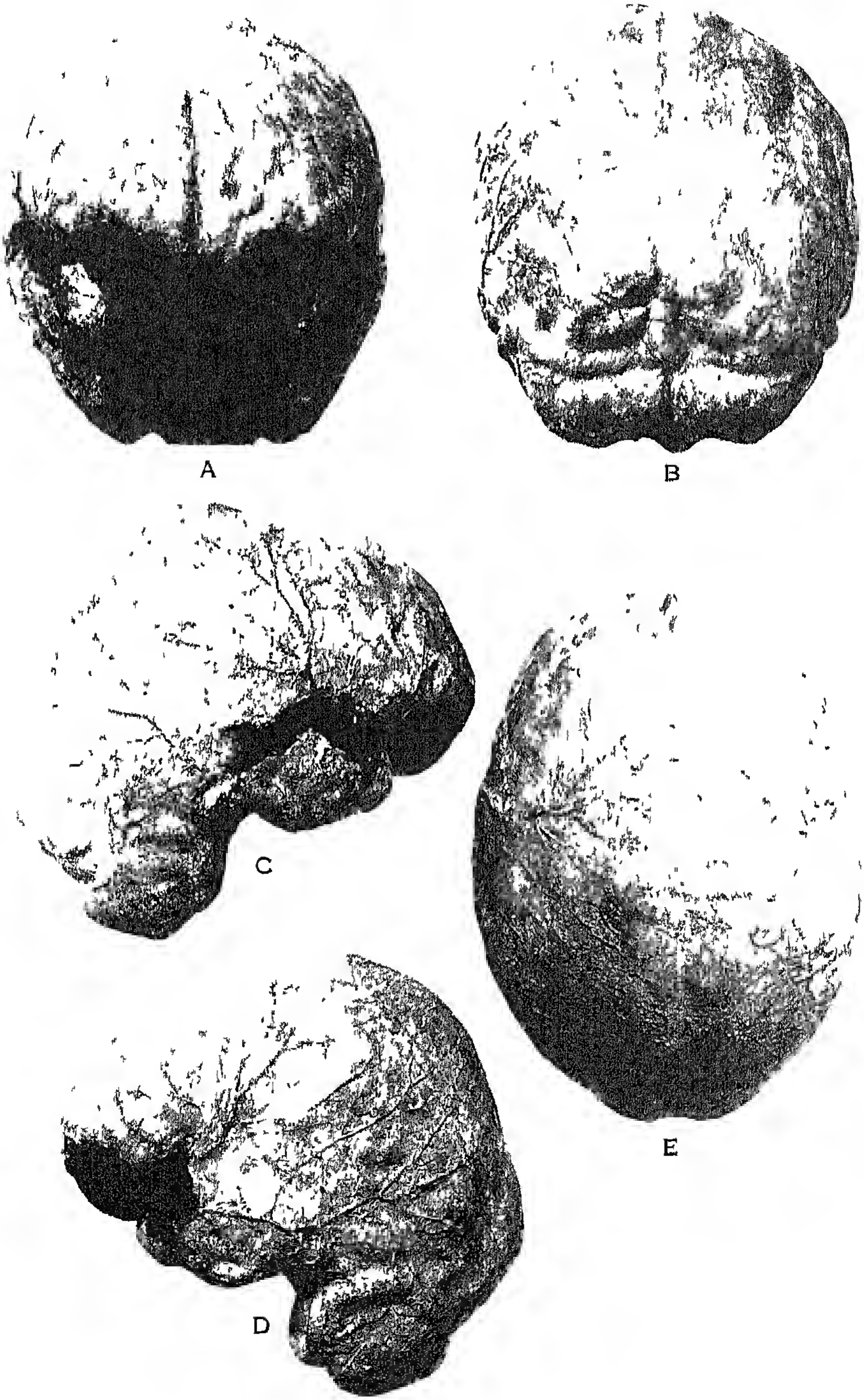
B

A

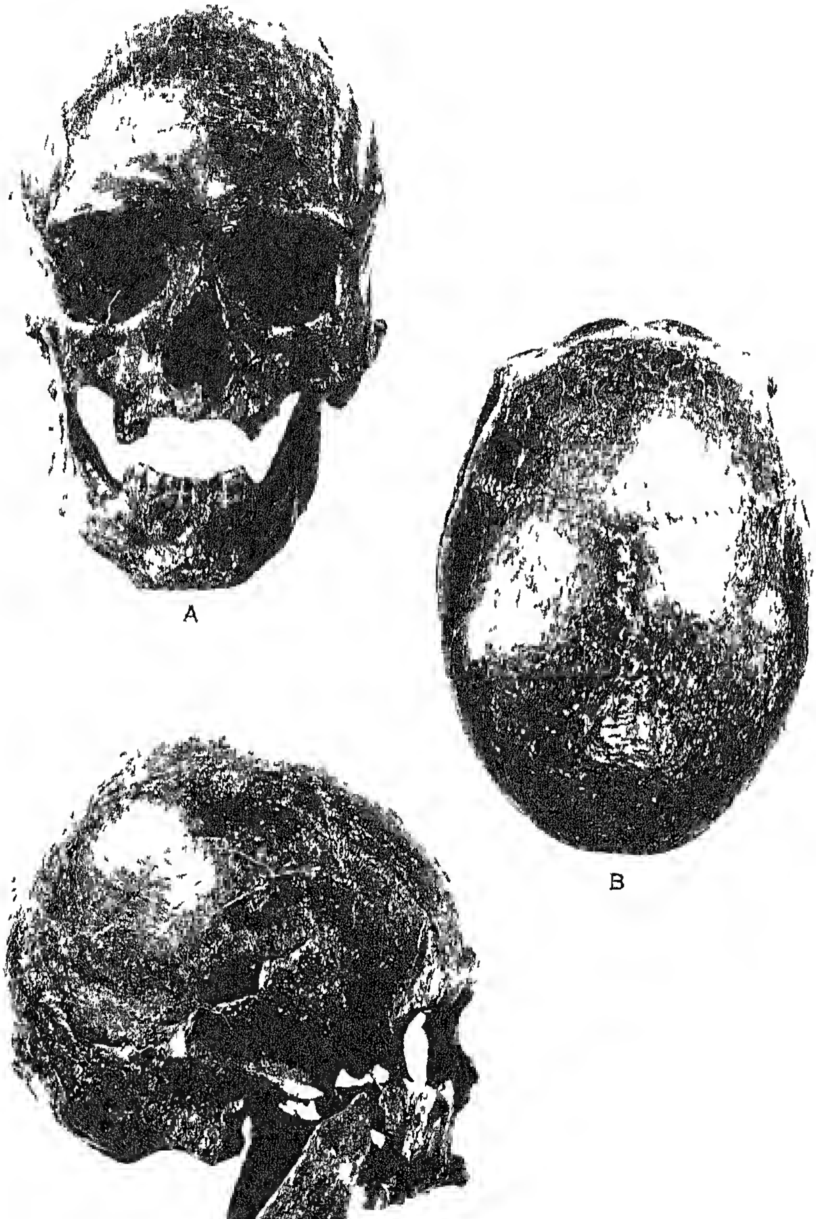
THE CARVED BONE OF TEPEXPAN



Pit No. 2

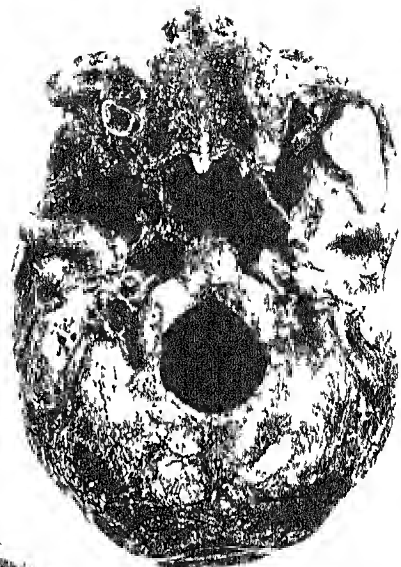


Views of the Endocast



THE SKULL AFTER RESTORATION

D

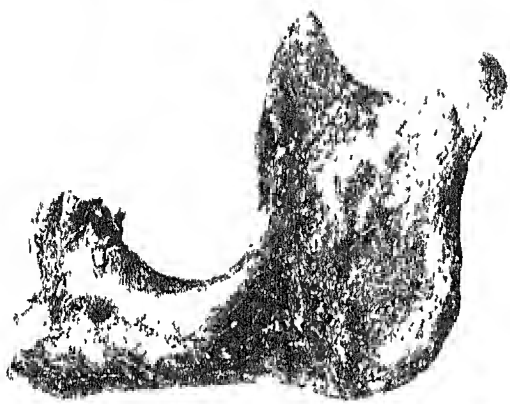


E

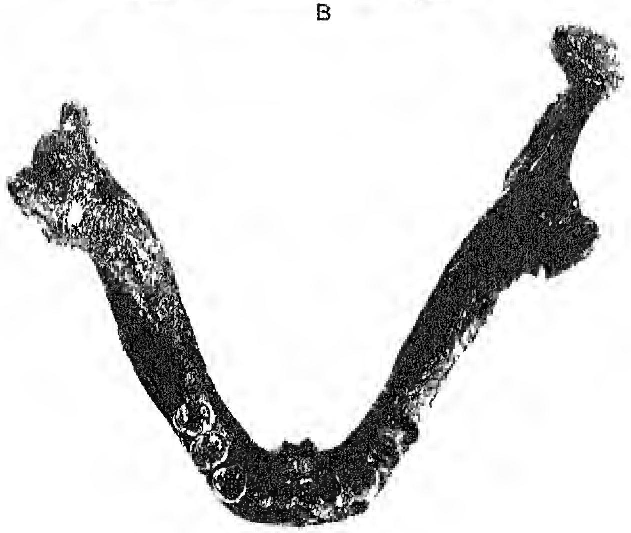
F

THE SKULL AFTER RESTORATION

A

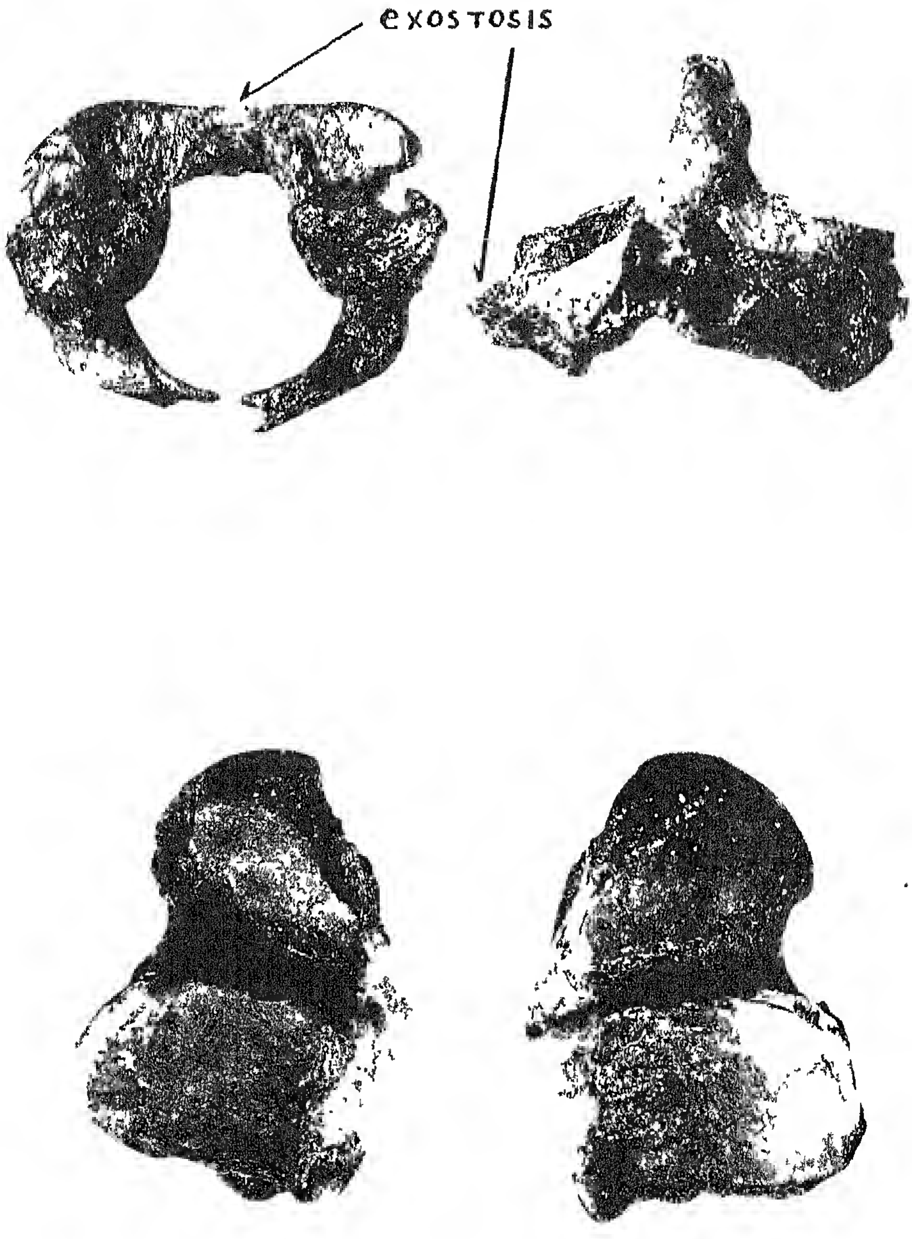


B

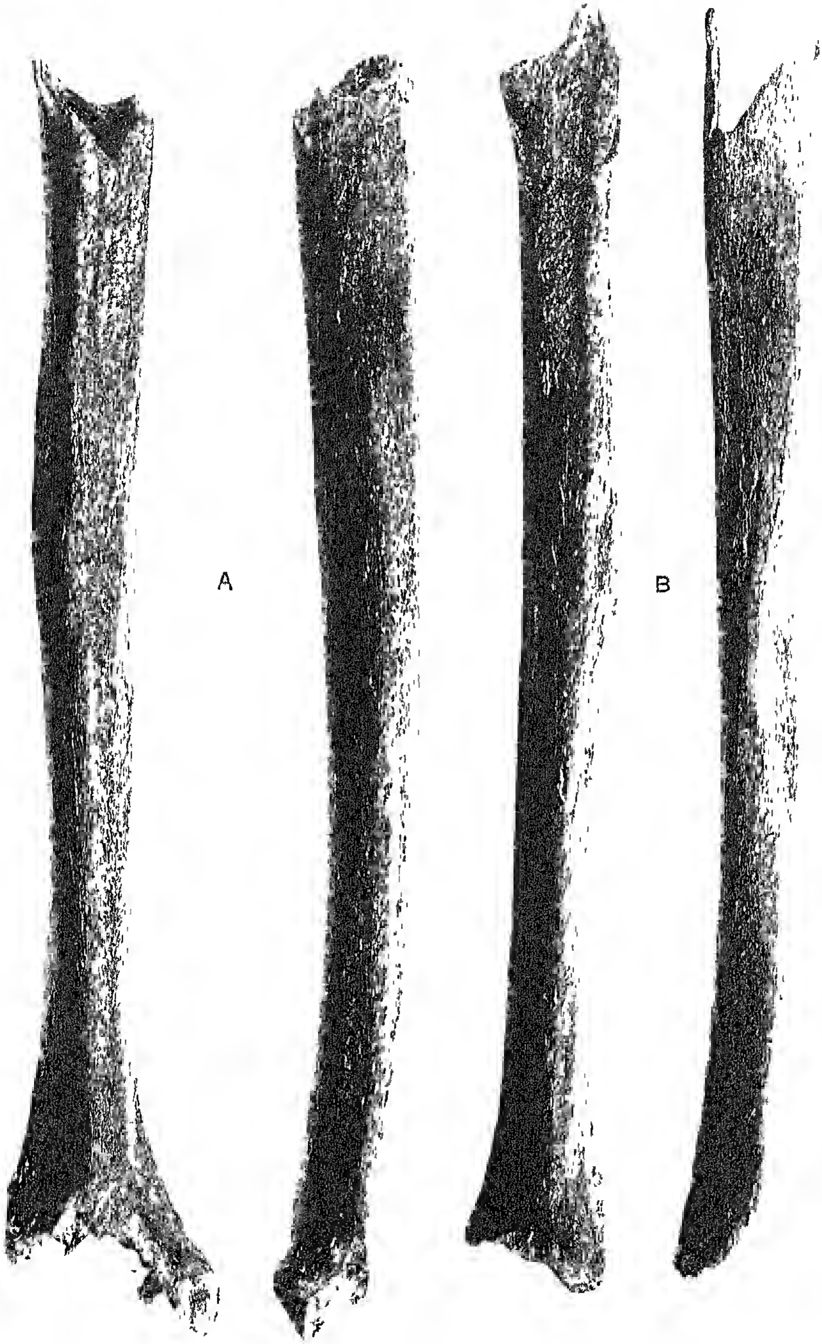


C

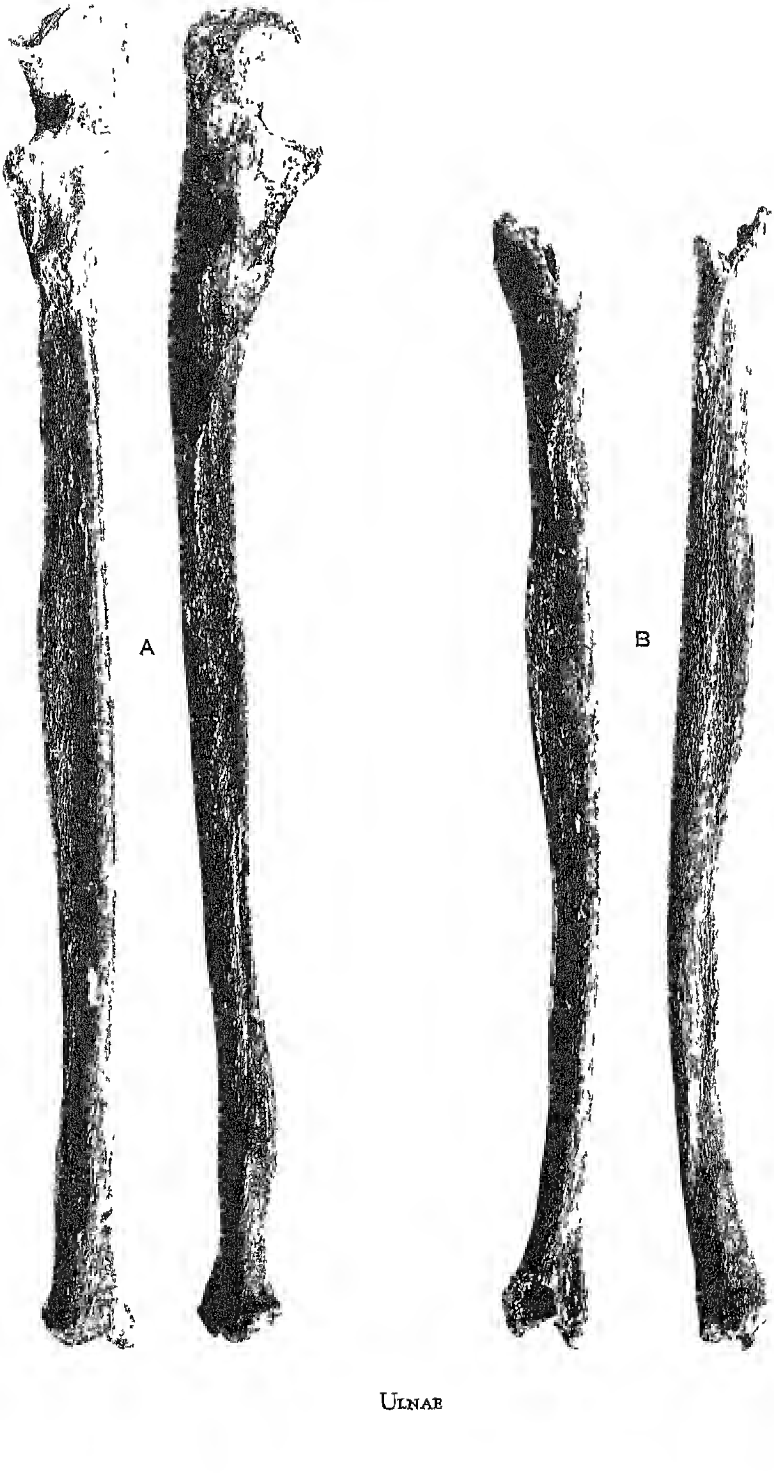
The Lower Jaw



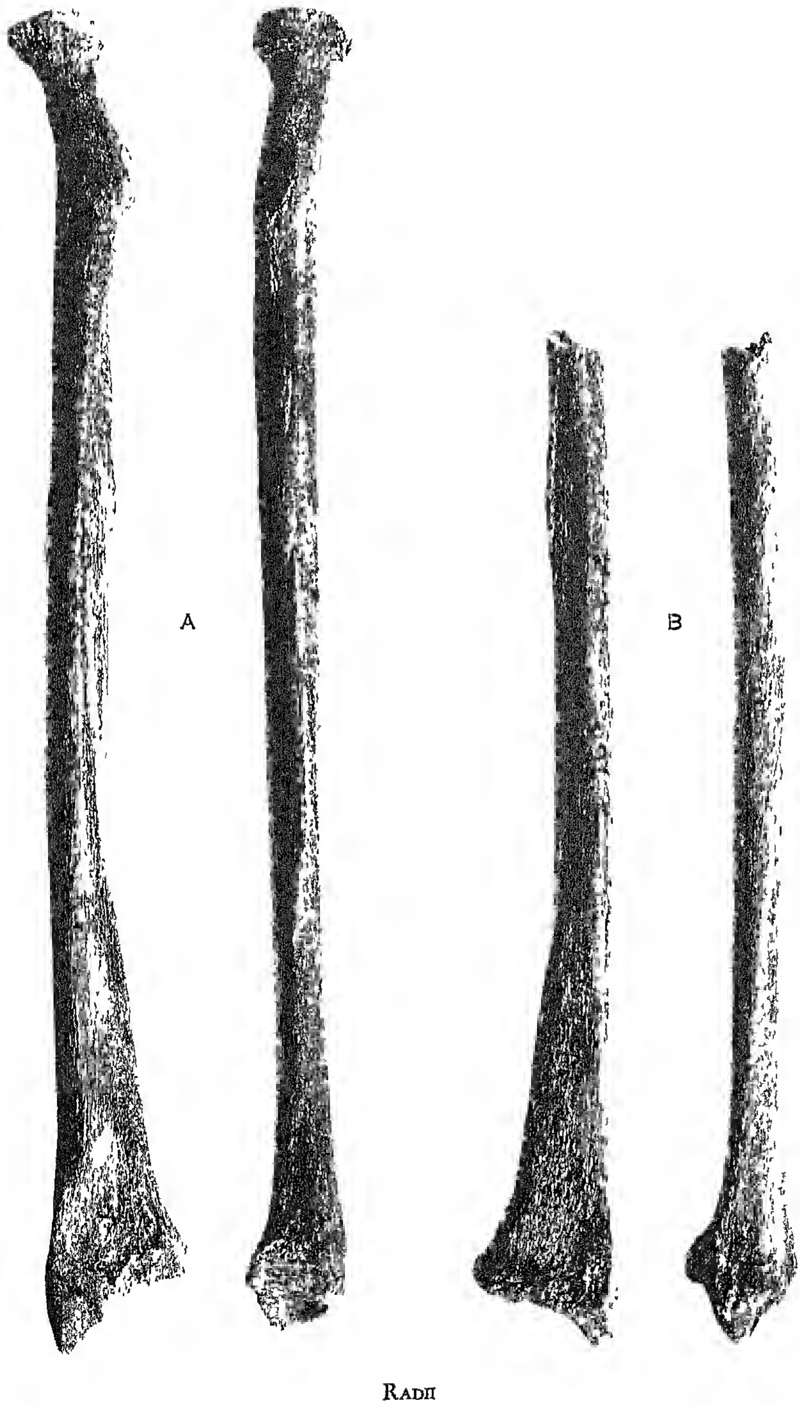
The Atlas, Epistropheus and Talus



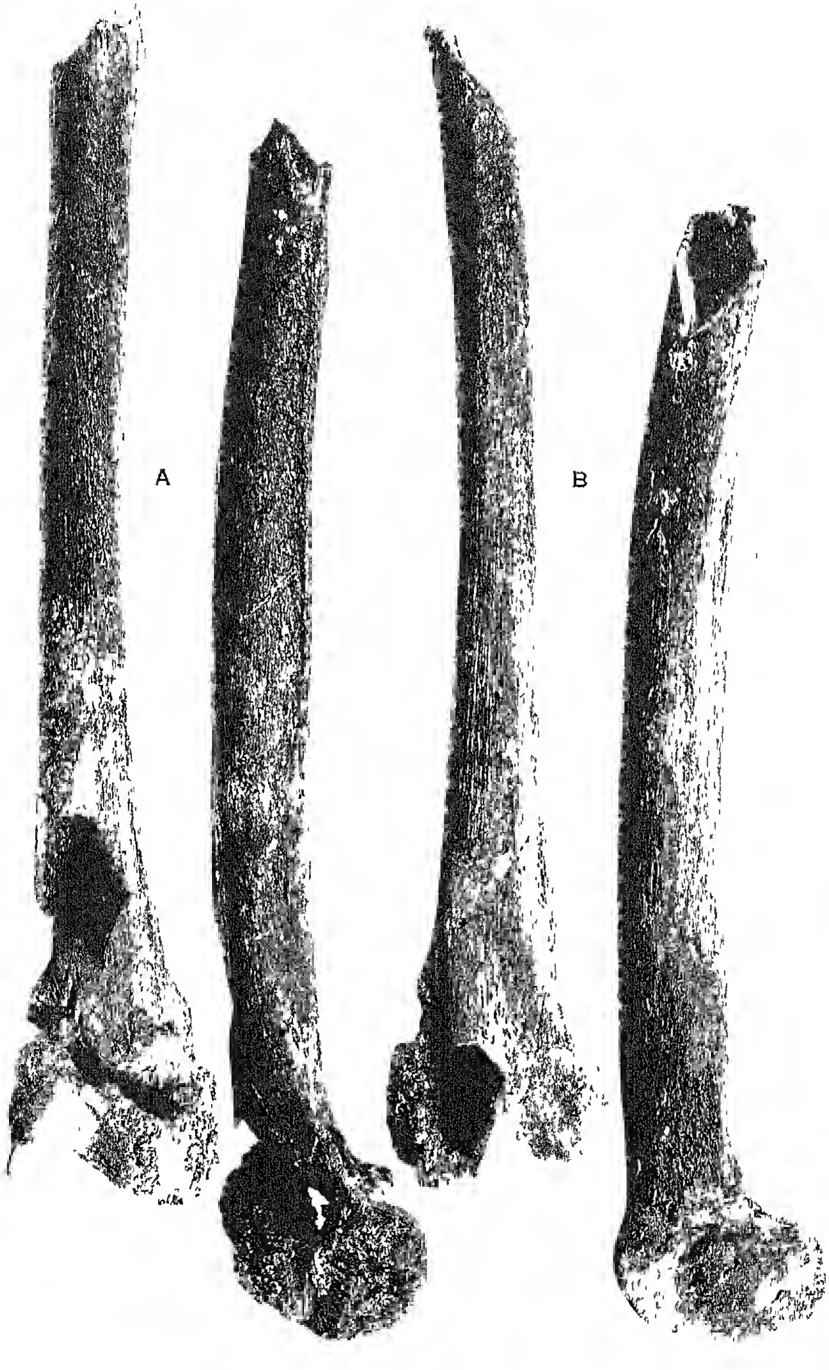
HUMERI



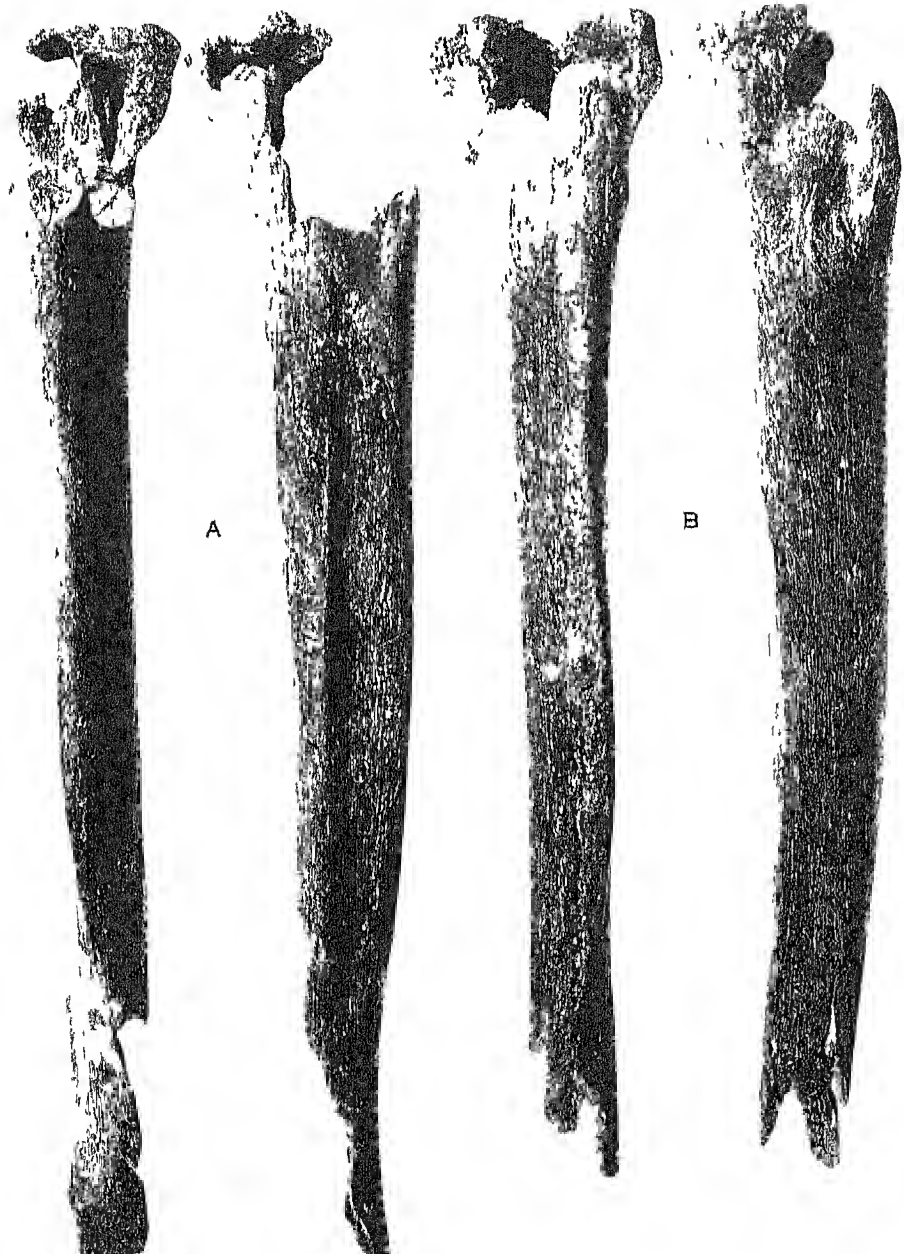
ULNAE



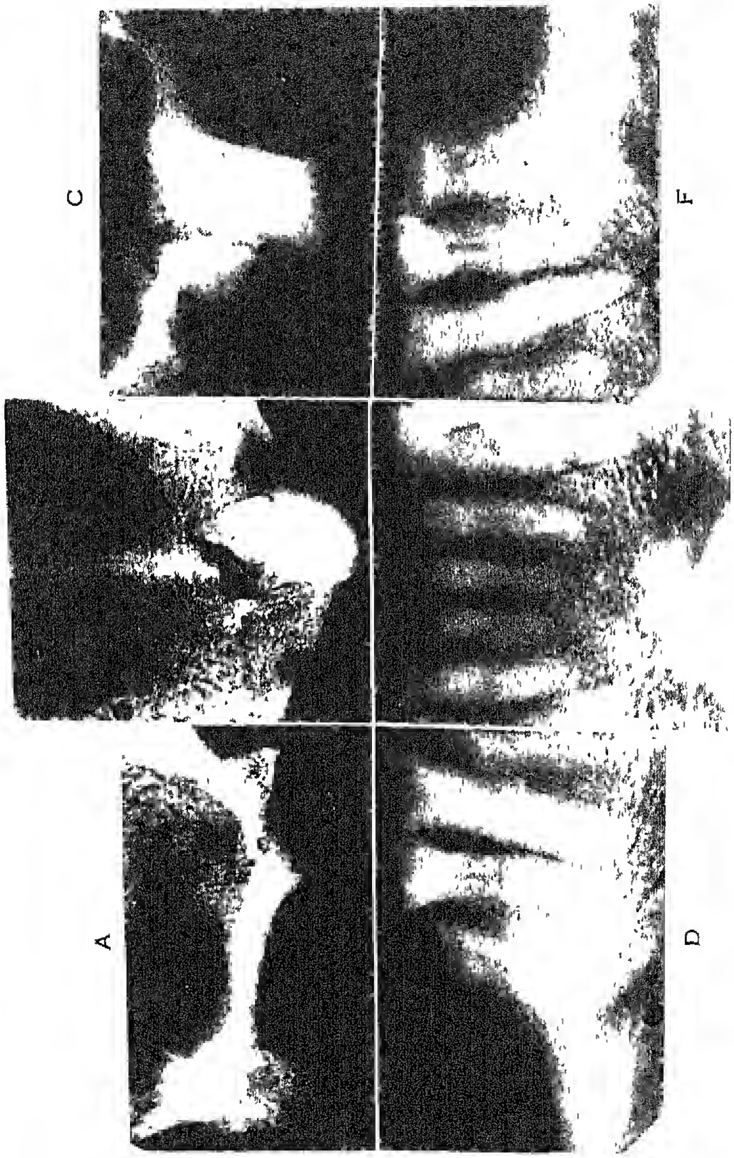
RADII



FEMORA



TIBIAE



RADIOGRAPHS

A

B

COMPARATIVE VIEWS OF TEPEXPAN AND TICOMAN SKULLS

COMPARATIVE VIEWS OF TEPEXPAN AND TICOMAN SKULLS